

APPENDIX E
DEVELOPMENT OF RISK-BASED TARGET LEVELS

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E.1 INTRODUCTION

Appendix E provides the inputs required to calculate default target levels (DTLs) and Tier 1 risk-based target levels. Several of these parameters, as explained in Section 9.0, may also be used in Tier 2 evaluation. Specifically the calculation of the Tier 1 risk-based target levels and the Tier 2 and 3 site-specific target levels requires the following:

- Acceptable risk level,
- Chemical-specific toxicological factors,
- Physical and chemical properties of the chemicals of concern (COCs),
- Receptor-specific exposure factors,
- Fate and transport parameters, and
- Mathematical models.

Each of these factors is discussed below. In addition, this appendix discusses the target levels for lead (Section E.10) and the estimation of risk and target levels when light or dense non-aqueous phase liquid (LNAPL/DNAPL) is present on/in the groundwater (Section E.11).

For Tier 1 risk assessments, Tier 1 risk-based target levels have been calculated by the department for each of the COCs, the receptors (child, adult resident, age-adjusted resident, non-residential worker, and construction worker), and the following exposure pathways using conservative assumptions applicable to most Missouri sites.

Pathways for Surficial Soils, defined as 0 to 3 feet below ground surface (bgs)

- Leaching to groundwater and potential use of groundwater,
- Leaching to groundwater and subsequent migration to a surface water body, and
- Ingestion of soil, dermal contact with soil, and outdoor inhalation of vapors and particulates emitted by surficial soils.

Pathways for Subsurface Soils, defined as greater than 3 feet bgs to the water table

- Volatilization and upward migration of vapors from subsurface soil and potential indoor inhalation of these vapor emissions,
- Leaching to groundwater and potential use of groundwater, and
- Leaching to groundwater and subsequent migration to a surface water body.

Pathways for Groundwater

- Volatilization and upward migration of vapors from groundwater and potential indoor inhalation of these vapor emissions,
- Volatilization and upward migration of vapors from groundwater and potential outdoor inhalation of these vapor emissions,
- Ingestion, inhalation and dermal contact of water if the domestic use of groundwater pathway is complete,

- Dermal contact with groundwater, and
- Migration to a surface water body and potential impacts to surface waters.

The following pathways for surface water and sediments are not included in Tier 1 calculations:

- Ingestion of surface water,
- Contact with surface water during recreational activities (ingestion, inhalation of vapors, and dermal contact),
- Ingestion of fish, and
- Contact with (accidental ingestion and dermal contact with) sediments.

Other Pathways

In a Tier 2 assessment, leaching to groundwater, horizontal migration of the plume under a building, and volatilization from the plume into the building are other surface and subsurface pathways that may be complete at some sites.

At some sites, other routes of exposure may be significant. At sites where these pathways are complete, they must be evaluated under Tier 3 risk assessment. These include exposure due to

- ingestion of produce grown in impacted soils,
- exposures associated with use of groundwater for irrigation purposes,
- use of groundwater for industrial purposes, or
- ingestion of fish or other aquatic organisms that have bioaccumulated COCs through the food chain as a result of surface water or sediment contamination.

The resultant Tier 1 risk-based target levels are presented in Appendix B. The Tier 1 risk-based target levels do not account for the presence of other exposure pathways and COCs (additive or cumulative risk).

For Tier 2 risk assessments, the remediating party must calculate the site-specific target levels using technically justifiable, site-specific data. The default fate and transport models used to develop the Tier 1 risk-based target levels must be used. For Tier 3 assessments, site-specific target levels would be calculated using site-specific data and possibly alternative fate and transport models, if approved by the department. Also refer to Table 2-1.

E.2 ACCEPTABLE RISK LEVEL

A risk-based decision making process requires the specification of an acceptable risk level for both carcinogenic and non-carcinogenic adverse health effects. For carcinogenic effects, risk is quantified using individual excess lifetime cancer risk (IELCR) and for non-carcinogenic effects, the risk is quantified using a hazard quotient (HQ) or hazard index (HI), which is the sum of hazard quotients when multiple chemicals and multiple exposure pathways are evaluated.

For domestic use of water, maximum contaminant levels (MCLs) are used as the target concentrations at the point of exposure. For COCs that do not have MCLs, the target concentration at the point of exposure (POE) is estimated assuming ingestion of groundwater, dermal contact and indoor inhalation of vapors due to water use under residential conditions.

Potential impacts to streams and other surface water bodies from a release must be evaluated and surface water quality protected as per 10 CSR 20-7.031. Allowable concentrations in surface water depend on the streams' designated beneficial use.

The Tier 1 risk-based target levels are based on acceptable risk levels of 1×10^{-5} for the carcinogenic chemicals and a hazard quotient of 1.0 for non-carcinogenic chemicals. The calculation of risk-based target levels does not account for cumulative site-wide risk. As explained in Section 8.6, these generic target levels may need to be adjusted to account for the cumulative site-wide risk. The acceptable risk levels are as follows:

Carcinogenic Risk

- The total risk for each COC, which is the sum of risk for all complete exposure pathways for each COC, must not exceed 1×10^{-5} .
- The cumulative site-wide risk (sum of risk for all COCs and all complete exposure pathways) must not exceed 1×10^{-4} .

Non-carcinogenic Risk

- The hazard index for each COC, which is the sum of hazard quotients for all complete exposure pathways for each COC must not exceed 1.0.
- The site-wide hazard index, which is the sum of hazard quotients for all COCs and all complete exposure pathways, must not exceed 1.0.

If the hazard index exceeds 1.0, the hazard index corresponding to a specific toxicological end point may be calculated by a qualified toxicologist. In this case, the specific hazard indices for each toxicological end point must be less than unity (1.0).

E.3 QUANTITATIVE TOXICITY FACTORS

Table E-1 gives the toxicity values for the over 300 chemicals (not including the petroleum fractions) considered in the Missouri Risk-Based Corrective Action (MRBCA) process.

Typically, these toxicity values will also be used for Tier 3 risk assessments, although alternate values may be used at Tier 3 with adequate justification and the approval of the department.

The toxicity data was extracted from the hierarchy of sources as per "***Human Health Toxicity Values in Superfund Risk Assessments***," ***OSWER directive 9285.7-53***,

December 5, 2003. Specifically it included:

1. Tier 1: Integrated Risk Information System (IRIS),
2. Tier 2: Provisional Peer Reviewed Toxicity Values (PPRTVs),
3. Tier 3: Miscellaneous Sources:
 - (i) National Center for Environmental Assessment (NCEA) as listed in USEPA's Region IX Preliminary Remediation Goal (PRG) Table,
 - (ii) California Office of Environmental Health Hazard Assessments (OEHHA) chemical database,
 - (iii) Health Effects Assessment Summary Tables (HEAST) as listed in USEPA's Region IX PRG tables, and
 - (iv) Table for Texas Risk Reduction Program.

Footnotes to Table E-1 indicate the source for each value.

Dermal toxicity values are not available in the above sources; therefore the dermal toxicity values were calculated. The assumption underlying the calculation of dermal toxicity values is that the dermal toxicity of the chemical is the same as the oral toxicity values, except that a semi-permeable barrier (the skin) affects absorption. Using oral toxicity values to calculate dermal toxicity values is based on sound toxicological principles, and in the absence of direct measurement of dermal toxicity, considered an acceptable alternative by the USEPA. However, the calculation is complicated due to the fact that different chemicals pass through the skin with different efficiencies. These differing efficiencies are factored into the formulae for dermal toxicity as the term "oral absorption factors (RAF_o)."

The formulae for calculation of slope factor (SF_d) and reference dose (RfD_d) for dermal exposure are as below:

$$SF_d = \frac{SF_o}{RAF_o} \quad (1)$$

$$RfD_d = RfD_o \times RAF_o \quad (2)$$

where,

- SF_o = Slope factor for oral exposure (mg/kg-day)⁻¹,
 RfD_o = Reference dose for oral exposure (mg/kg-day)⁻¹, and
 RAF_o = Oral absorption factor (dimensionless).

The oral absorption factors are not readily available. Conservatively, a value of 1.0 was assigned for all chemicals.

The dermal absorption factors were obtained from the ***Risk Assessment Guidance for Superfund (RAGS), Volume 1: Human Health Evaluation Manual, Part E Supplemental Guidance for Dermal Risk Assessment*** (USEPA, 2004). However, this guidance does not have any recommendations for volatile organic compounds (VOCs), or inorganic compounds. For these compounds, the absorption factors were obtained from the USEPA Region III and RAGS, Volume 1, Part A.

The parameters used for dermal contact pathway are shown in Table E-2 and are discussed below:

Permeability Coefficient

For organic chemicals, the chemical-specific permeability coefficients in water were obtained from Exhibit B-3 of the *RAGS Volume I, Part E* (USEPA, 2004). For chemicals not listed in Exhibit B-3, the permeability constant, K_p (cm/hr), was estimated using the following equation as per the *RAGS Volume I, Part E* (USEPA, 2004):

$$\log K_p = -2.80 + 0.66(\log K_{ow}) - 0.0056MW \quad (3)$$

where,

K_{ow}	=	Octanol-water partition coefficient (dimensionless), and
MW	=	Molecular weight (g/mole).

Note the MW and K_{ow} are presented in Table E-3.

For metals and inorganics, the permeability coefficients were obtained from Exhibit B-4 of the *RAGS Volume I, Part E* (USEPA, 2004). If no value is available, the permeability coefficient of 1×10^{-3} cm/hr is recommended as default value (USEPA, 2004).

Relative Contribution of Permeability Coefficient

The relative contribution of permeability coefficients for the chemicals was obtained from Exhibit B-3 of the *RAGS Volume I, Part E* (USEPA, 2004). For chemicals not listed in Exhibit B-3, the relative contribution of permeability coefficient, B (unitless), was estimated using the following equation as per the *RAGS Volume I, Part E* (USEPA, 2004):

$$B = K_p \frac{\sqrt{MW}}{2.6} \quad (4)$$

Lag Time

The lag times for the chemicals, τ_{event} (hr/event), were obtained from Exhibit B-3 of the *RAGS Volume I, Part E* (USEPA, 2004).

As per the *RAGS Volume I, Part E* (USEPA, 2004), the equation to estimate τ_{event} is derived as below:

$$\frac{D_{sc}}{l_{sc}} = 10^{(-2.80 - 0.0056MW)} \quad (5)$$

$$\tau_{event} = \frac{l_{sc}^2}{6 \times D_{sc}} \quad (6)$$

where,

- | | | |
|----------|---|--|
| D_{sc} | = | Effective diffusion coefficient for chemical transfer through the stratum corneum (cm^2/hr), and |
| l_{sc} | = | Apparent thickness of stratum corneum (cm). |

The lag time is dependent on the effective diffusion coefficient for chemical transfer through the stratum corneum and the apparent thickness of stratum corneum. Assuming $l_{sc} = 10^{-3}$ cm as a default value for the thickness of the stratum corneum, τ_{event} becomes:

$$\tau_{event} = 0.105 \times 10^{(0.0056 MW)} \quad (7)$$

For chemicals not listed in Exhibit B-3, τ_{event} was estimated using Equation (7).

Equation (7) is based on the assumption that all chemicals absorbed into the skin during the exposure event would eventually be absorbed into the systemic circulation, with the stratum corneum being the main barrier for most chemicals. For highly lipophilic chemicals, the viable epidermis can be a significant barrier for chemical transfer from the stratum corneum to the systemic circulation. When this occurs, the relative rate of desquamation of the stratum corneum and cell proliferation rate at the base of the viable epidermis contribute to a net decrease in the total amount of absorbed chemical. For similar reasons, stratum corneum desquamation can reduce the amount of absorption for chemicals that are not highly lipophilic but large enough that penetration through the stratum corneum is slow.

Time to Reach Steady-State

The time to reach steady-state for the chemicals considered were obtained from Exhibit B-3 of the *RAGS Volume I, Part E* (USEPA, 2004). For chemicals not listed in Exhibit B-3, the time to reach steady-state, t^* (hr), was estimated using the following equation as per the *RAGS Volume I, Part E* (USEPA, 2004):

If $B < 0.6$ or $B = 0.6$,

$$t^* = 2.4\tau_{event} \quad (6)$$

If $B > 0.6$,

$$t^* = 6\tau_{event} \times \left(b - \sqrt{b^2 - c^2} \right) \quad (7)$$

where b and c are correlation coefficient which have been fitted to the data from Flynn,

G.L. (1990) and are expressed as below:

$$c = \frac{1+3B+3B^2}{3(1+B)} \text{ and } b = 2 \times \frac{(1+B)^2}{\pi} - c.$$

Fraction Absorbed Water

The fraction absorbed water for the chemicals considered were obtained from Exhibit B-3 of the *RAGS Volume I, Part E* (USEPA, 2004). For chemicals not listed in Exhibit B-3, the fraction absorbed water, *FA* (unitless), was estimated from Exhibit A-5 of the *RAGS Volume I, Part E* (USEPA, 2004).

E.4 PHYSICAL AND CHEMICAL PROPERTIES OF THE COCs

Physical and chemical properties of the COCs are listed in Table E-2. These values must be used for all MRBCA evaluations unless there are justifiable reasons to modify these values and the department approves the alternative values. The use of different values would be allowed only under a Tier 3 risk assessment.

The following hierarchy was used to obtain the physical and chemical properties:

- (i) Missouri Department of Natural Resources, Cleanup Levels for Missouri (CALM), (2001) (This MRBCA process replaces CALM),
- (ii) USEPA Region IX, PRG's Inter Calc Tables, (2002),
- (iii) Texas Commission on Environmental Quality (TCEQ), Texas Risk Reduction Program (TRRP), (2004), and
- (iv) Idaho Department of Environmental Quality (IDEQ), RBCA Tables, (2003).

Footnotes on Table E-2 indicate the source for each value.

E.5 EXPOSURE FACTORS

A list of the exposure factors and the values that were used to develop generic Tier 1 risk-based target level values is presented in Table E-3. The exposure factors are typically estimated based on literature rather than site-specific measurements. For a Tier 3 risk assessment, site-specific exposure factors may be used with clear justification and the department's approval. For the evaluation of inhalation exposures, the values of both the exposure time (hours/day) and inhalation rate (cubic meters/day) are significant and interrelated.

A source of exposure factor information is USEPA's *Exposure Factors Handbook Volume 1 – General Factors* (August 1997). Other sources of exposure factor data may be used for Tier 3 risk assessment with approval of the department.

E.6 FATE AND TRANSPORT PARAMETERS

Fate and transport parameters are necessary to estimate the target levels for the indirect routes of exposure. These factors characterize the physical site properties such as depth

to groundwater, soil porosity, and infiltration rate at a site. For a Tier 1 risk assessment, the department has selected typical conservative default values that are listed in Table E-4 for three generic vadose zone soil types. These include:

- soil type 1, representative of a sandy soil,
- soil type 2, representative of a silty soil, and
- soil type 3, representative of clayey soil.

See Appendix O for more information on determination of soil types.

For a Tier 2 risk assessment, a combination of site-specific and default fate and transport values may be used. However, the value of each parameter used, whether site-specific or default, must be justified based on site-specific conditions. Where site-specific conditions are significantly different from the Tier 1 assumptions, site-specific values should be used.

For a Tier 3 risk assessment, the specific fate and transport parameters required to calculate the target levels would depend on the model used.

E.7 MATHEMATICAL MODELS

The input parameters mentioned above are used in two types of models, or equations, to calculate the risk-based target levels. These are the (i) uptake equations and (ii) fate and transport models. For Tier 1 and Tier 2 risk assessments, the department has selected the models and equations included in this appendix for use.

For Tier 2 risk assessments, the department requires the use of the same equations and models. With the prior approval of the department through the submittal of a Tier 3 work plan, a different set of models may be used for Tier 3 risk assessments.

E.8 TARGET LEVELS FOR PROTECTION OF DOMESTIC USE OF GROUNDWATER

A schematic of the domestic use pathway is shown in Section 6, Figure 6.2. If the groundwater use pathway is deemed to be complete under current or future conditions, it must be quantitatively evaluated as follows:

Step 1: Identify the critical point of exposure (POE). The POE is the nearest down-gradient, three-dimensional location that could reasonably be considered for installation of a groundwater supply well. The POE does not need to be an actual existing well; the POE well could be a hypothetical well. Further the POE may be screened in a deeper uncontaminated zone, and not necessarily a shallow contaminated water bearing zone.

Step 2: Determine target levels at the POE. For COCs that have MCLs, the target level at the POE will be the MCL. For COCs that do not have MCLs, the target levels will be the risk-based calculated value that assumes groundwater ingestion, dermal contact and indoor inhalation of vapors emitted due to water use. Note that the indoor inhalation of

vapors based on water use pathway will be considered only for volatile COCs (refer to Figure E-1).

Step 3: Identification of point of demonstration (POD) wells and calculation of target levels at the POD. POD wells are located between the source and the POE to monitor the COC concentrations in groundwater as a means of protecting against exceedances at the POE. Risk-based target concentrations will be developed for the POD using appropriate fate and transport models and site-specific parameters as explained in Section E-12.

Step 4: Calculation of representative soil COC concentrations in the area of release. Risk-based target levels for soil should also be calculated for the area of release using the equations and models presented in this appendix.

This step requires an evaluation of the dilution and attenuation of the COC in the unsaturated zone. For Tier 1 and Tier 2 evaluation, the following depth dependent unsaturated zone dilution attenuation factor (DAF) values were used:

Depth to groundwater less than 20 feet, DAF = 1

Depth to groundwater 20-50 feet, DAF = 2

Depth to groundwater >50 feet, DAF = 4

Thus the quantitative evaluation of this pathway requires the calculation of target levels at the (i) POE, (ii) POD, and (iii) soil source. These concentrations must be compared with representative concentrations for this pathway.

E.9 TARGET LEVELS FOR PROTECTION OF SURFACE WATER BODIES

Potential impacts to streams and other surface water bodies from a release must be evaluated and surface water quality protected as per 10 CSR 20-7.031. Sampling for COCs in surface water bodies will be necessary when COC migration is known or suspected to adversely affect a surface water body.

E.9.1 Protection of Streams

Protection of streams requires the (i) determination of stream classification, (ii) identification of the use designations of the stream, (iii) estimation of allowable COC concentrations in the stream, (iv) determination of stream 7Q10, and (v) calculation of allowable COC concentrations at various locations within the stream and the groundwater plume. The latter include:

- Instream COC concentrations at the instream point of compliance (for example, downstream edge of a mixing zone, if applicable) (C_{sw}),
- Instream COC concentrations at the downstream edge of the zone of initial dilution, if applicable (C_{zid}),
- Groundwater COC concentrations at the point of discharge of the groundwater plume to the surface water body (C_{gw}),

- Groundwater COC concentrations at points of demonstration at different distances between the source and the point of discharge (C_{pod}), and
- Soil COC concentrations at the source area soils (C_{soil}).

The locations of these various points are schematically shown in Figure E-2. Depending on site-specific conditions, sampling for COC concentrations at one or more of these locations may be necessary.

The procedure for protection of streams and surface waters is shown in Figure E-3 and discussed below:

Step 1: Determine stream classification: As per 10 CSR 20-7.031(1)(F), streams in Missouri are classified as Class C, Class P, or P1 waters. Stream classification applies to specific reaches of a stream and not necessarily to the entire stream length. Classification of streams and the length of the classified segment can be found in Table H of 10 CSR 20-7.031. Streams not included in Table H are unclassified (Class U) and have no assigned designated uses.

Step 2: Determine the beneficial use designation(s) of the stream: As per 10 CSR 20-7.031(1)(C), beneficial uses of a stream include one or more of the following:

- Irrigation (IRR),
- Livestock & Wildlife Watering (LWW),
- Protection of Warm Water Aquatic Life and Human Health – Fish Consumption (AQL),
- Cool Water =Fishery (CLF),
- Cold Water Fishery (CDF),
- Whole Body Recreation (WBR),
- Secondary Contact Recreation (SCR)
- Drinking Water Supply (DWS), and
- Industrial (IND).

Beneficial use designations for classified streams are tabulated in Table H of 10 CSR 20-7.031. A stream may have multiple beneficial use designations, in which case all beneficial uses must be identified.

Step 3: Determine stream water quality criteria: Stream water quality criteria depend on the beneficial use designation(s) of the stream and can be found in Table A of 10 CSR 20-7.031. For streams with multiple beneficial uses, select the most protective applicable criteria. For metals, the criteria for the protection of aquatic life depend on the hardness of water. For specific water quality criteria, refer to 10 CSR 20-7.031, Table A.

If COCs for which water quality criteria are not available are present at a site, contact the department's project manager for consultation with the Water Protection Program (WPP).

For Class P and P1 streams, water quality criteria must be met at the downstream edge of the mixing zone. As defined in 10 CSR 20-7.031(1)(P), a mixing zone is "an area of

dilution of effluent in the receiving water beyond which chronic toxicity criteria must be met". For Class C and unclassified streams, applicable water quality criteria must be met at the point of groundwater discharge to the stream.

Step 4: Determine 7Q10 and groundwater discharge: The 7Q10 low-flow of a stream is the average minimum flow for seven consecutive days that has a probable recurrence interval of once-in-ten years. Estimation of 7Q10 must follow current practices as included in USGS and USEPA literature. The lowest value of 7Q10 that can be used as a default value for a Tier 1 risk assessment that includes Class P or P1 streams is 0.1 cubic feet per second (cfs). Class C and unclassified streams have a default 7Q10 value of 0.0 cfs. Also, the volume of impacted groundwater discharging into the stream must be determined. This determination is based on the dimensions of the plume at the point of discharge and an average Darcy velocity at the point of discharge. For flow-regulated streams, contact the department's WPP for the estimation of 7Q10.

Step 5: Estimate concentrations at the groundwater point of discharge: The concentrations at the point of discharge can be estimated using mass balance considerations. For streams with a 7Q10 of 0.1 cfs or greater, the stream flow to be used in the calculation is 0.25 of the 7Q10 flow calculated in Step 4. The specific equations are included in Appendix E, Section E-12.

Step 6: Estimate groundwater and soil concentrations: Applicable COC concentrations for soil and groundwater can be back-calculated using the concept of DAFs. The specific equations, a combination of the Summer and Domenico's models, are presented in Appendix E, Section E-12.

The soil and groundwater COC concentrations discussed above apply to the protection of surface water. Other routes of exposure from groundwater, such as inhalation of volatiles and ingestion of groundwater, must also be evaluated as part of the process. Therefore, cleanup criteria based on these routes of exposure may result in allowable COC concentrations that are lower than those protective of a surface water body.

Step 7:Other considerations: Numeric water quality criteria must be met as per the following:

- For unclassified streams, the acute criteria must be met at the point of discharge,
- For an unclassified stream that flows into a classified stream or becomes a classified stream downstream of the point of discharge, the acute criteria must be met at the point of groundwater discharge to the unclassified stream; chronic criteria must be met at the downstream classified water body.
- For Class C streams, the acute criteria do not apply and chronic criteria must be met in the Class C water body.
- For Class P and P1 streams, the acute criteria must be met at the edge of the zone of initial dilution and throughout the mixing zone; chronic criteria must be met at the downstream edge of the mixing zone.

In addition to numeric water quality criteria, general water quality criteria must be met in waters of the state at all times, including mixing zones. General water quality criteria are discussed in 10 CSR 20-7.031(3).

E.9.2 Protection of Lakes

The above considerations also apply to lakes. However, the mixing zone can not exceed one-quarter ($\frac{1}{4}$) of the lake width at the discharge point or one hundred feet (100 feet) from the discharge point, whichever is less. A zone of initial dilution is not allowed in lakes.

E.10 TARGET LEVELS FOR LEAD

Lead has a number of toxic effects, but the main target for lead toxicity is the nervous system. Young children are especially vulnerable from the standpoint of both exposure and toxicity. Certain behaviors, such as crawling and playing on the floor or ground, result in increased exposure, and the central nervous system of a young child is particularly susceptible because it is still developing. Chronic exposure to even low levels of lead that are not overly toxic can result in impaired mental development.

USEPA has developed a model [Integrated Exposure Uptake Biokinetic (IEUBK) Model] to predict the risk of elevated blood lead (PbB) in children under the age of seven who are exposed to environmental lead from various sources. The model predicts the probability that a child exposed to lead concentrations in a specified media will have a PbB level greater than 10 micrograms per deciliter ($\mu\text{g}/\text{dL}$), the level associated with adverse health effects (USEPA, 1999).

Because of the greater vulnerability of children to exposure and toxicity, the primary concern in a residential setting is risk to children. In the non-residential scenario, children are not generally directly exposed, but fetuses carried by female workers can be exposed. The USEPA has developed an adult lead methodology (ALM) to assess risk in this scenario (USEPA, 1996). The methodology is limited in terms of exposure media (soil/dust). Specifically, the methodology estimates the PbB concentrations in fetuses carried by women exposed to lead contaminated soils. Research is ongoing to develop a model capable of simulating multimedia exposures over the entire human lifetime. Until this model is developed, the department will require the use of IEUBK for residential and ALM for non-residential scenarios, if the responsible party chooses to perform a site-specific evaluation for lead and concentrations exceed the following generic levels:

Residential land use soil (direct contact with soil)	260 mg/kg
Non-residential land use soil (direct contact with soil)	660 mg/kg

The above soil concentrations do not account for leaching to groundwater. At sites where this pathway is complete or potentially complete, the department may require a site-specific analysis. Where domestic use of groundwater is a complete pathway, the groundwater target level is 0.015 mg/L.

E.11 TARGET LEVEL CALCULATION FOR LNAPL/DNAPL

The MRBCA process allows for the calculation of risk and target levels when LNAPL or DNAPL is present. Under this condition, the primary routes of exposure are (i) indoor inhalation for a residential or a non-residential receptor, and, (ii) if the domestic use of groundwater pathway is complete or potentially complete, the protection of a current or potential future point of exposure (POE) groundwater well. For these pathways, the key step is the calculation of the vapor concentration and the dissolved concentration emanating from the LNAPL/DNAPL. Once these concentrations have been estimated, risk and target levels can be determined using the procedures presented in Sections E.2 to E.9 above.

Soil Vapor Concentration: The soil vapor concentration in equilibrium with LNAPL/DNAPL is the effective soil vapor concentration. This concentration depends on (i) the chemical-specific saturated soil vapor concentration, and (ii) the mole fraction of the chemical in the LNAPL/DNAPL for which the soil vapor concentration is being calculated. If the mole fraction of a COC is not known, default mole fractions, calculated using the weight fraction of a specific COC in the LNAPL/DNAPL, may be used if the NAPL can be analyzed and its components determined. Alternatively, the evaluator may sample the LNAPL/DNAPL for laboratory analysis to determine site-specific values for the weight and mole fractions. The specific equations used to calculate the effective soil vapor or effective dissolved concentrations are presented in Section E.12.

In the forward model of risk assessment, the effective soil vapor and dissolved concentrations can be used to calculate the risk due to indoor inhalation or to estimate the concentration in the point of demonstration (POD) and POE wells. If DNAPL is located below the water table, pathways related to inhalation of vapors generated from the DNAPL will be considered incomplete, as vapors will not penetrate the overlying column of saturated soil.

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E.12 MODELS/EQUATIONS FOR ESTIMATING DTLs AND TIER 1 AND 2 RISK-BASED TARGET LEVELS WITHIN THE MRBCA PROCESS

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**INDOOR INHALATION OF VAPORS
(CHILD AND ADULT RESIDENT; AND NON-RESIDENTIAL WORKER)**

Carcinogenic effects

$$RBTL_{ai} = \frac{TR \times BW \times AT_c \times 365}{IR_{ai} \times ET_{in} \times ED \times EF \times SF_i}$$

Non-carcinogenic effects

$$RBTL_{ai} = \frac{THQ \times BW \times AT_{nc} \times 365 \times RfD_i}{IR_{ai} \times ET_{in} \times ED \times EF}$$

Source: RAGS, Vol. I, Part A, 1989, p. 6-44

where:

$RBTL_{ai}$	= Risk-based target level in indoor air [mg/m ³]
TR	= Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
THQ	= Target hazard quotient for individual constituents [-]
BW	= Body weight [kg]
AT_c	= Averaging time for carcinogens[year]
AT_{nc}	= Averaging time for non-carcinogens[year]
IR_{ai}	= Indoor inhalation rate [m ³ /hr]
ET_{in}	= Indoor exposure time [hr/day]
ED	= Exposure duration [year]
EF	= Exposure frequency [day/year]
RfD_i	= Chemical-specific inhalation reference dose [mg/kg-day]
SF_i	= Chemical-specific inhalation cancer slope or potency factor [(mg/kg-day) ⁻¹]
365	= Converts AT_c , AT_{nc} in years to days [day/year]

OUTDOOR INHALATION OF VAPORS (CONSTRUCTION WORKER)

Carcinogenic effects

$$RBTL_{ao} = \frac{TR \times BW \times AT_c \times 365}{IR_{ao} \times ET_{out} \times ED \times EF \times SF_i}$$

Non-carcinogenic effects

$$RBTL_{ao} = \frac{THQ \times BW \times AT_{nc} \times 365 \times RfD_i}{IR_{ao} \times ET_{out} \times ED \times EF}$$

Source: RAGS, Vol. I, Part A, 1989, p. 6-44

where:

- $RBTL_{ao}$ = Risk-based target level in outdoor air [mg/m³]
- TR = Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
- THQ = Target hazard quotient for individual constituents [-]
- BW = Body weight [kg]
- AT_c = Averaging time for carcinogens[year]
- AT_{nc} = Averaging time for non-carcinogens[year]
- IR_{ao} = Outdoor inhalation rate [m³/hr]
- ET_{out} = Outdoor exposure time [hr/day]
- ED = Exposure duration [year]
- EF = Exposure frequency [day/year]
- RfD_i = Chemical-specific inhalation reference dose [mg/kg-day]
- SF_i = Chemical-specific inhalation cancer slope or potency factor [(mg/kg-day)⁻¹]
- 365 = Converts AT_c, AT_{nc} in years to days [day/year]

DERMAL CONTACT WITH CHEMICALS IN WATER
(CHILD AND ADULT RESIDENT; NON-RESIDENTIAL WORKER; AND CONSTRUCTION WORKER)

Carcinogenic effects

$$RBTL_{dw} = \frac{TR \times BW \times AT_c \times 365 \times 1000}{SF_d \times SA_{gw} \times EV_{gw} \times Z \times EF \times ED}$$

Non-carcinogenic effects

$$RBTL_{dw} = \frac{THQ \times BW \times AT_{nc} \times 365 \times 1000 \times RfD_d}{SA_{gw} \times EV_{gw} \times Z \times EF \times ED}$$

For organic chemicals,

$$\text{If } t_{event} \leq t^*, \text{ then } Z = 2 \times FA \times K_p \sqrt{6\tau_{event} \frac{t_{event}}{\pi}}$$

$$\text{If } t_{event} > t^*, \text{ then } Z = FA \times K_p \left[\frac{t_{event}}{1+B} + 2\tau_{event} \left(\frac{1+3B+3B^2}{(1+B)^2} \right) \right]$$

$$\text{For inorganic chemicals, } Z = K_p \times t_{event}$$

where:

$RBTL_{dw}$	= Risk-based target level for dermal contact with groundwater [mg/L]
TR	= Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
THQ	= Target hazard quotient for individual constituents [-]
BW	= Body weight [kg]
AT_c	= Averaging time for carcinogens [year]
AT_{nc}	= Averaging time for non-carcinogens [year]
SA_{gw}	= Skin surface area available for contact with water [cm^2]
EV_{gw}	= Event frequency [event/day]
ED	= Exposure duration [year]
EF	= Exposure frequency [day/year]
RfD_d	= Chemical-specific dermal reference dose [mg/kg-day]
SF_d	= Chemical-specific dermal cancer slope or potency factor [$\text{mg}/(\text{kg}\cdot\text{day})^{-1}$]
365	= Converts AT_c , AT_{nc} in years to days [day/year]
1000	= Conversion factor from cm^3 to L [cm^3/L]
t_{event}	= Event duration [hr/event]
t^*	= Chemical-specific time to reach steady-state [hr]
Z	= Chemical-specific dermal factor [cm/event]
K_p	= Chemical-specific dermal permeability coefficient [cm/hr]
FA	= Chemical-specific fraction absorbed in water [-]
τ_{event}	= Chemical-specific lag time [hr/event]
B	= Chemical-specific relative contribution of permeability coefficient [-]

$$B = K_P \frac{\sqrt{MW}}{2.6}$$

$$\log K_P = -2.80 + 0.66 \log K_{OW} - 0.0056 MW$$

If $B < 0.6$ or $B = 0.6$, then, $t^* = 2.4\tau_{event}$

If $B > 0.6$ then, $t^* = 6\tau_{event} \times (b - \sqrt{b^2 - c^2})$

where,

$$c = \frac{1 + 3B + 3B^2}{3(1 + B)}$$

$$b = 2 \times \frac{(1 + B)^2}{\pi} - c$$

$$\tau_{event} = 0.105 \times 10^{(0.0056 MW)}$$

Source: Modified from RAGS, Vol. I, Part E, 2004.

where:

MW = Molecular weight [g/mole]

K_{OW} = Octanol water partition coefficient [L/kg]

b, c = Correlation coefficient which have been fitted to the data from Flynn, G.L. (1990)

**DOMESTIC WATER USE (CHILD AND ADULT RESIDENT)
(ONLY FOR CHEMICALS WITHOUT MAXIMUM CONTAMINANT LEVELS)**

Carcinogenic effects

$$RBT_{w} = \frac{TR \times BW \times AT_c \times 365}{ED \times EF \times \left[(SF_o \times IR_w) + (SF_i \times ET \times K_f \times IR_a) + \left(\frac{SF_d}{1000} \times SA_{wb} \times EV_{wb} \times Z_{wb} \right) \right]}$$

Non-carcinogenic effects

$$RBT_{w} = \frac{THQ \times BW \times AT_{nc} \times 365}{ED \times EF \times \left[\left(\frac{I}{RfD_o} \times IR_w \right) + \left(\frac{1}{RfD_i} \times K_f \times ET \times IR_a \right) + \left(\frac{SA_{wb} \times EV_{wb} \times Z_{wb}}{RfD_d \times 1000} \right) \right]}$$

For organic chemicals,

$$\text{If } t_{wb\text{-event}} \leq t^*, \text{ then } Z_{wb} = 2 \times FA \times K_p \sqrt{6\tau_{event} \frac{t_{wb\text{-event}}}{\pi}}$$

$$\text{If } t_{wb\text{-event}} > t^*, \text{ then } Z_{wb} = FA \times K_p \left[\frac{t_{wb\text{-event}}}{1+B} + 2\tau_{event} \left(\frac{1+3B+3B^2}{(1+B)^2} \right) \right]$$

For inorganic chemicals, $Z_{wb} = K_p \times t_{wb\text{-event}}$

Note: $K_f = 0$ for non-volatile chemicals (i.e., chemicals with a molecular weight > 200 and Henry's law constant (dimensionless) $< 4.2 \times 10^{-4}$ or Henry's law constant (atm-m³/mol) $< 1.5 \times 10^{-5}$).

Source: Modified from RAGS, Vol. I, Part E, 2004.

where:

$RBTL_w$	=	Risk-based target level for ingestion of groundwater [mg/L-H ₂ O]
TR	=	Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
THQ	=	Target hazard quotient for individual constituents [-]
BW	=	Body weight [kg]
AT_c	=	Averaging time for carcinogens [year]
AT_{nc}	=	Averaging time for non-carcinogens [year]
IR_w	=	Water ingestion rate [L/day]
IR_a	=	Indoor inhalation rate [m ³ /hr]
ED	=	Exposure duration [year]
EF	=	Exposure frequency [day/year]
K_f	=	Volatilization factor [L/m ³]
ET	=	Exposure time [hr/day]
SA_{wb}	=	Skin surface area available for whole-body contact with water [cm ²]
EV_{wb}	=	Event frequency for whole-body contact with water [event/day]
RfD_o	=	Chemical-specific oral reference dose [mg/kg-day]
RfD_i	=	Chemical-specific inhalation reference dose [mg/kg-day]
RfD_d	=	Chemical-specific dermal reference dose [mg/kg-day]
SF_o	=	Chemical-specific oral cancer slope or potency factor [mg/(kg-day)] ⁻¹
SF_i	=	Chemical-specific inhalation cancer slope or potency factor [(mg/kg-day) ⁻¹]
SF_d	=	Chemical-specific dermal cancer slope or potency factor [mg/(kg-day)] ⁻¹
365	=	Converts AT_c , AT_{nc} in years to days [day/year]
1000	=	Conversion factor from cm ³ to L [cm ³ /L]
$t_{wb\text{-}event}$	=	Event duration for whole-body contact [hr/event]
t^*	=	Chemical-specific time to reach steady-state [hr]
Z_{wb}	=	Chemical-specific dermal factor for whole-body contact [cm/event]
K_p	=	Chemical-specific dermal permeability coefficient [cm/hr]
FA	=	Chemical-specific fraction absorbed in water [-]
τ_{event}	=	Chemical-specific lag time [hr/event]
B	=	Chemical-specific relative contribution of permeability coefficient [-]

DERMAL CONTACT WITH CHEMICALS IN SOIL
(CHILD AND ADULT RESIDENT; NON-RESIDENTIAL WORKER; AND CONSTRUCTION WORKER)

Carcinogenic effects

$$RBTL_{dcss} = \frac{TR \times BW \times AT_c \times 365}{EF \times ED \times SF_d \times 10^{-6} \times SA_{soil} \times EV_{soil} \times AF \times RAF_d}$$

Non-carcinogenic effects

$$RBTL_{dcss} = \frac{THQ \times BW \times AT_{nc} \times 365 \times RfD_d}{EF \times ED \times 10^{-6} \times SA_{soil} \times EV_{soil} \times AF \times RAF_d}$$

Source: Modified from RAGS, Vol. I, Part E, 2004.

where:

- $RBTL_{dcss}$ = Risk-based target level for dermal contact of chemicals in surficial soil [mg/kg]
- TR = Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
- THQ = Target hazard quotient for individual constituents [-]
- BW = Body weight [kg]
- AT_c = Averaging time for carcinogens [year]
- AT_{nc} = Averaging time for non-carcinogens [year]
- ED = Exposure duration [year]
- EF = Exposure frequency [day/year]
- SA_{soil} = Skin surface area available for contact with soil [cm^2]
- EV_{soil} = Event frequency [event/day]
- AF = Soil to skin adherence factor [$\text{mg}/\text{cm}^2\text{-event}$]
- RAF_d = Chemical-specific dermal relative absorption factor [-]
- SF_d = Dermal cancer slope factor [$(\text{mg}/\text{kg}\cdot\text{day})^{-1}$]
- RfD_d = Chemical-specific oral reference dose [$\text{mg}/\text{kg}\cdot\text{day}$]
- 365 = Converts AT_c, AT_{nc} in years to days [day/year]

**INGESTION OF CHEMICALS IN SOIL
(CHILD AND ADULT RESIDENT; NON-RESIDENTIAL WORKER; AND CONSTRUCTION WORKER)**

Carcinogenic effects

$$RBTL_{ingss} = \frac{TR \times BW \times AT_c \times 365}{EF \times ED \times SF_o \times 10^{-6} \times IR_{soil} \times RAF_o}$$

Non-carcinogenic effects

$$RBTL_{ingss} = \frac{THQ \times BW \times AT_{nc} \times 365 \times RfD_o}{EF \times ED \times 10^{-6} \times IR_{soil} \times RAF_o}$$

where:

- $RBTL_{ingss}$ = Risk-based target level for ingestion of chemicals in surficial soil [mg/kg]
- TR = Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
- THQ = Target hazard quotient for individual constituents [-]
- BW = Body weight [kg]
- AT_c = Averaging time for carcinogens [year]
- AT_{nc} = Averaging time for non-carcinogens [year]
- ED = Exposure duration [year]
- EF = Exposure frequency [day/year]
- IR_{soil} = Soil ingestion rate [mg/day]
- RAF_o = Oral relative absorption factor [-]
- SF_o = Oral cancer slope factor $[(\text{mg/kg-day})^{-1}]$
- 365 = Converts AT_c, AT_{nc} in years to days [day/year]

**INHALATION OF VAPORS AND PARTICULATES OF CHEMICALS IN SOIL
(CHILD AND ADULT RESIDENT; NON-RESIDENTIAL WORKER; AND CONSTRUCTION WORKER)**

Carcinogenic effects

$$RBTL_{inhss} = \frac{TR \times BW \times AT_c \times 365}{EF \times ED \times SF_i \times IR_{ao} \times ET_{out} \times (VF_{ss} + VF_p)}$$

Non-carcinogenic effects

$$RBTL_{inhss} = \frac{THQ \times BW \times AT_{nc} \times 365 \times RfD_i}{EF \times ED \times ET_{out} \times IR_{ao} \times (VF_{ss} + VF_p)}$$

Note: $VF_{ss} = 0$ for non-volatile chemicals (i.e., chemicals with a molecular weight > 200 and Henry's law constant (dimensionless) < 4.2×10^{-4} or Henry's law constant (atm-m³/mol) < 1.5×10^{-5}).

where:

- $RBTL_{inhss}$ = Risk-based target level of inhalation of chemicals in surficial soil [mg/kg]
- TR = Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
- THQ = Target hazard quotient for individual constituents [-]
- BW = Body weight [kg]
- AT_c = Averaging time for carcinogens [year]
- AT_{nc} = Averaging time for non-carcinogens [year]
- ED = Exposure duration [year]
- EF = Exposure frequency [day/year]
- IR_{ao} = Outdoor inhalation rate [m³/hr]
- ET_{out} = Outdoor exposure time [hr/day]
- SF_i = Inhalation cancer slope factor [(mg/kg-day)⁻¹]
- RfD_i = The chemical-specific inhalation reference dose [mg/kg-day]
- VF_p = Volatilization factor for particulate emissions from surficial soil [(mg/m³-air)/(mg/kg-soil)]
- VF_{ss} = Volatilization factor for vapor emissions from surficial soil [(mg/m³-air)/(mg/kg-soil)]
- 365 = Converts AT_c, AT_{nc} in years to days [day/year]

Note: The depth to surficial soil for a construction worker is up to the typical construction depth.

**INHALATION OF VAPORS AND PARTICULATES, DERMAL CONTACT WITH, AND INGESTION OF
CHEMICALS IN SOIL
(CHILD AND ADULT RESIDENT; NON-RESIDENTIAL WORKER; AND CONSTRUCTION WORKER)**

Carcinogenic effects

$$RBTL_{ss} = \frac{TR \times BW \times AT_c \times 365}{EF \times ED \times [(SF_o \times 10^{-6} \times IR_{soil} \times RAF_o) + (SF_d \times 10^{-6} \times SA_{soil} \times EV_{soil} \times AF \times RAF_d) + (SF_i \times IR_{ao} \times ET_{out} \times (VF_{ss} + VF_p))]}$$

Non-carcinogenic effects

$$RBTL_{ss} = \frac{THQ \times BW \times AT_{nc} \times 365}{EF \times ED \times \left[\frac{10^{-6} \times IR_{soil} \times RAF_o}{RfD_o} + \frac{10^{-6} \times SA_{soil} \times EV_{soil} \times AF \times RAF_d}{RfD_d} + \frac{ET_{out} \times IR_{ao} \times (VF_{ss} + VF_p)}{RfD_i} \right]}$$

Source: Modified from RAGS, Vol. I, Part E, 2004.

where:

$RBTL_{ss}$	=	Risk-based target level of surficial soil [mg/kg]
TR	=	Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
THQ	=	Target hazard quotient for individual constituents [-]
BW	=	Body weight [kg]
AT_c	=	Averaging time for carcinogens [year]
AT_{nc}	=	Averaging time for non-carcinogens [year]
ED	=	Exposure duration [year]
EF	=	Exposure frequency [day/year]
IR_{soil}	=	Soil ingestion rate [mg/day]
RAF_o	=	Oral relative absorption factor [-]
SA	=	Skin surface area [cm^2/day]
EV_{soil}	=	Event frequency [event/day]
AF	=	Soil to skin adherence factor [mg/cm^2]
RAF_d	=	Dermal relative adsorption factor [-]
IR_{ao}	=	Outdoor inhalation rate [m^3/hr]
ET_{out}	=	Outdoor exposure time [hr/day]
SF_o	=	Oral cancer slope factor [$(\text{mg}/\text{kg}\cdot\text{day})^{-1}$]
SF_i	=	Inhalation cancer slope factor [$(\text{mg}/\text{kg}\cdot\text{day})^{-1}$]
RfD_o	=	The chemical-specific oral reference dose [$\text{mg}/\text{kg}\cdot\text{day}$]
RfD_i	=	The chemical-specific inhalation reference dose [$\text{mg}/\text{kg}\cdot\text{day}$]
VF_p	=	Volatilization factor for particulate emissions from surficial soil [$(\text{mg}/\text{m}^3\text{-air})/(\text{mg}/\text{kg-soil})$]
VF_{ss}	=	Volatilization factor for vapor emissions from surficial soil [$(\text{mg}/\text{m}^3\text{-air})/(\text{mg}/\text{kg-soil})$]
365	=	Converts AT_c , AT_{nc} in years to days [day/year]

INDOOR INHALATION OF VAPORS (AGE-ADJUSTED RESIDENT)

Carcinogenic effects

$$RBTL_{ai\text{-}adj} = \frac{TR \times AT_c \times 365}{IR_{ai\text{-}aa} \times SF_i}$$

Non-carcinogenic effects

$$RBTL_{ai\text{-}adj} = \frac{THQ \times AT_{nc} \times 365 \times RfD_i}{IR_{ai\text{-}aa}}$$

where:

$$IR_{ai\text{-}aa} = \frac{IR_{ai\text{-}c} \times ED_c \times EF_c \times ET_{i\text{-}c}}{BW_c} + \frac{IR_{ai\text{-}a} \times ED_a \times EF_a \times ET_{i\text{-}a}}{BW_a}$$

Source: Modified from RAGS, Vol. I, Part B, 1991

where:

$RBTL_{ai-adj}$	=	Age-adjusted risk-based target level in indoor air [mg/m ³]
TR	=	Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
THQ	=	Target hazard quotient for individual constituents [-]
AT_c	=	Averaging time for carcinogens [year]
AT_{nc}	=	Averaging time for non-carcinogens [year]
IR_{ai-aa}	=	Age-adjusted indoor inhalation rate [m ³ /kg]
IR_{ai-c}	=	Resident child indoor inhalation rate [m ³ /hr]
IR_{ai-a}	=	Resident adult indoor inhalation rate [m ³ /hr]
ED_c	=	Exposure duration for child [year]
ED_a	=	Exposure duration for an adult [year]
EF_c	=	Exposure frequency for a child [day/year]
EF_a	=	Exposure frequency for an adult [day/year]
ET_{i-c}	=	Indoor exposure time for a child [hour/day]
ET_{i-a}	=	Indoor exposure time for an adult [hour/day]
BW_c	=	Resident child body weight [kg]
BW_a	=	Resident adult body weight [kg]
RfD_i	=	Chemical-specific inhalation reference dose [mg/kg-day]
SF_i	=	Chemical-specific inhalation cancer slope factor [mg/kg-day] ⁻¹
365	=	Conversion factor [day/year]

DERMAL CONTACT WITH CHEMICALS IN WATER (AGE-ADJUSTED RESIDENT)

Carcinogenic effects

$$RBTL_{dcw-adj} = \frac{TR \times AT_c \times 365 \times 1000}{SF_d \times (DC_{w-c} \times Z_c + DC_{w-a} \times Z_a)}$$

Non-carcinogenic effects

$$RBTL_{dcw-adj} = \frac{THQ \times AT_{nc} \times 365 \times 1000 \times RfD_d}{DC_{w-c} \times Z_c + DC_{w-a} \times Z_a}$$

where :

$$DC_{w-c} = \frac{ED_c \times EF_c \times SA_{gw-c} \times EV_{gw-c}}{BW_c}$$

$$DC_{w-a} = \frac{ED_a \times EF_a \times SA_{gw-a} \times EV_{gw-a}}{BW_a}$$

For organic chemicals,

$$\text{If } t_{event} \leq t^*, \text{ then } Z = 2 \times FA \times K_p \sqrt{6\tau_{event} \frac{t_{event}}{\pi}}$$

If $t_{event} > t^*$, then

$$Z = FA \times K_p \left[\frac{t_{event}}{1+B} + 2\tau_{event} \left(\frac{1+3B+3B^2}{(1+B)^2} \right) \right]$$

For inorganic chemicals, $Z = K_p \times t_{event}$

Source: Modified from RAGS, Vol. I, Part E, 2004.

where:

$RBL_{dcw-adj}$	=	Age-adjusted risk-based target level for dermal contact with chemicals in groundwater [mg/L-water]
TR	=	Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
THQ	=	Target hazard quotient for individual constituents [-]
AT_c	=	Averaging time for carcinogens [year]
AT_{nc}	=	Averaging time for non-carcinogens [year]
RfD_d	=	Chemical-specific dermal reference dose [mg/kg-day]
SF_d	=	Chemical-specific dermal cancer slope or potency factor [(mg/kg-day) ⁻¹]
365	=	Converts AT_c , AT_{nc} in years to days [day/year]
1000	=	Conversion factor from cm ³ to L [cm ³ /L]
t_{event}	=	Event duration [hr/event]
t^*	=	Chemical-specific time to reach steady-state [hr]
K_p	=	Chemical-specific dermal permeability coefficient [cm/hr]
FA	=	Chemical-specific fraction absorbed in water [-]
τ_{event}	=	Chemical-specific lag time [hr/event]
B	=	Chemical-specific relative contribution of permeability coefficient [-]
DC_{w-c}	=	Child dermal contact rate with groundwater [cm ² -event/kg]
DC_{w-a}	=	Adult dermal contact rate with groundwater [cm ² -event/kg]
EV_{gw-c}	=	Resident child event frequency [event/day]
EV_{gw-a}	=	Resident adult event frequency [event/day]
Z_c	=	Resident child chemical-specific dermal factor [cm/event]
Z_a	=	Resident adult chemical-specific dermal factor [cm/event]
SA_{gw-c}	=	Resident child skin surface area available for contact with water [cm ²]
SA_{gw-a}	=	Resident adult skin surface area available for contact with water [cm ²]
BW_c	=	Resident child body weight [kg]
BW_a	=	Resident adult body weight [kg]
ED_c	=	Resident child exposure duration [year]
ED_a	=	Resident adult exposure duration [year]
EF_c	=	Exposure frequency for a child [day/year]
EF_a	=	Exposure frequency for an adult [day/year]

**DOMESTIC WATER USE (AGE-ADJUSTED RESIDENT)
(ONLY FOR CHEMICALS WITHOUT MAXIMUM CONTAMINANT LEVELS)**

Carcinogenic effects

$$RBTL_{w\text{-}adj} = \frac{TR \times AT_c \times 365}{\left[(SF_o \times IR_{w\text{-}aa}) + (SF_i \times K_f \times IR_{a\text{-}aa}) + \left(\frac{SF_d}{1000} \times (DC_{wb\text{-}c} \times Z_{wb\text{-}c} + DC_{wb\text{-}a} \times Z_{wb\text{-}a}) \right) \right]}$$

Non-carcinogenic effects

$$RBTL_{w\text{-}adj} = \frac{THQ \times AT_{nc} \times 365}{\left[\left(\frac{1}{RfD_o} \times IR_{w\text{-}aa} \right) + \left(\frac{1}{RfD_i} \times K_f \times IR_{a\text{-}aa} \right) + \left(\frac{(DC_{wb\text{-}c} \times Z_{wb\text{-}c} + DC_{wb\text{-}a} \times Z_{wb\text{-}a})}{RfD_d \times 1000} \right) \right]}$$

where:

$$IR_{w\text{-}aa} = \frac{ED_c \times EF_c \times IR_{w\text{-}c}}{BW_c} + \frac{ED_a \times EF_a \times IR_{w\text{-}a}}{BW_a}$$

$$IR_{a\text{-}aa} = \frac{ED_c \times EF_c \times ET_c \times IR_{a\text{-}c}}{BW_c} + \frac{ED_a \times EF_a \times ET_a \times IR_{a\text{-}a}}{BW_a}$$

$$DC_{wb\text{-}c} = \frac{ED_c \times EF_c \times SA_{wb\text{-}c} \times EV_{wb\text{-}c}}{BW_c} \quad \text{and} \quad DC_{wb\text{-}a} = \frac{ED_a \times EF_a \times SA_{wb\text{-}a} \times EV_{wb\text{-}a}}{BW_a}$$

For organic chemicals,

$$\text{If } t_{wb\text{-event}} \leq t^*, \text{ then } Z_{wb} = 2 \times FA \times K_p \sqrt{6\tau_{event} \frac{t_{wb\text{-event}}}{\pi}}$$

$$\text{If } t_{wb\text{-event}} > t^*, \text{ then } Z_{wb} = FA \times K_p \left[\frac{t_{wb\text{-event}}}{1+B} + 2\tau_{event} \left(\frac{1+3B+3B^2}{(1+B)^2} \right) \right]$$

For inorganic chemicals, $Z_{wb} = K_p \times t_{wb\text{-event}}$

Note: $K_f = 0$ for non-volatile chemicals (i.e., chemicals with a molecular weight > 200 and Henry's law constant (dimensionless) $< 4.2 \times 10^{-4}$ or Henry's law constant (atm-m³/mol) $< 1.5 \times 10^{-5}$).

Source: Modified from RAGS, Vol. I, Part E, 2004.

where:

$RBTL_{w\text{-adj}}$	=	Age-adjusted risk-based target level for ingestion of groundwater [mg/L-H ₂ O]
TR	=	Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
THQ	=	Target hazard quotient for individual constituents [-]
AT_c	=	Averaging time for carcinogens [year]
AT_{nc}	=	Averaging time for non-carcinogens [year]
RfD_o	=	Chemical-specific oral reference dose [mg/kg-day]
RfD_d	=	Chemical-specific dermal reference dose [mg/kg-day]
SF_o	=	Chemical-specific oral cancer slope or potency factor [(mg/kg-day) ⁻¹]
SF_i	=	Chemical-specific inhalation cancer slope or potency factor [(mg/kg-day) ⁻¹]
SF_d	=	Chemical-specific dermal cancer slope or potency factor [mg/(kg-day)] ⁻¹
$IR_{w\text{-aa}}$	=	Age-adjusted groundwater ingestion rate [L/kg]
$IR_{w\text{-c}}$	=	Resident child groundwater ingestion rate [L/day]
$IR_{a\text{-c}}$	=	Resident child inhalation rate [m ³ /hr]
$IR_{w\text{-a}}$	=	Resident adult groundwater ingestion rate [L/day]

IR_{a-a}	=	Resident adult inhalation rate [m^3/hr]
DC_{wb-c}	=	Child dermal whole-body contact rate with groundwater [$\text{cm}^2\text{-event/kg}$]
DC_{wb-a}	=	Adult dermal whole-body contact rate with groundwater [$\text{cm}^2\text{-event/kg}$]
BW_c	=	Resident child body weight [kg]
BW_a	=	Resident adult body weight [kg]
ED_c	=	Resident child exposure duration [year]
ET_c	=	Resident child exposure time [hr/day]
ET_a	=	Resident adult exposure time [hr/day]
ED_a	=	Resident adult exposure duration [year]
EF_c	=	Exposure frequency for a child [day/year]
EF_a	=	Exposure frequency for an adult [day/year]
K_f	=	Volatilization factor [L/m^3]
SA_{wb}	=	Skin surface area available for whole-body contact with water [cm^2]
EV_{wb}	=	Event frequency for whole-body contact with water [event/day]
365	=	Conversion factor [day/year]
1000	=	Conversion factor from cm^3 to L [cm^3/L]
$t_{wb\text{-event}}$	=	Event duration for whole-body contact [hr/event]
t^*	=	Chemical-specific time to reach steady-state [hr]
Z_{wb}	=	Chemical-specific dermal factor for whole-body contact [cm/event]
K_p	=	Chemical-specific dermal permeability coefficient [cm/hr]
FA	=	Chemical-specific fraction absorbed in water [-]
τ_{event}	=	Chemical-specific lag time [hr/event]
B	=	Chemical-specific relative contribution of permeability coefficient [-]

DERMAL CONTACT WITH CHEMICALS IN SOIL (AGE-ADJUSTED RESIDENT)

Carcinogenic effects

$$RBT{L_{dcss-adj}} = \frac{{TR \times AT_c \times 365}}{{SF_d \times SA_{soil-aa} \times RAF_d \times 10^{-6}}}$$

Non-carcinogenic effects

$$RBT{L_{dcss-adj}} = \frac{{THQ \times AT_{nc} \times 365 \times RfD_d}}{{SA_{soil-aa} \times RAF_d \times 10^{-6}}}$$

where:

$$SA_{soil-aa} = \frac{{ED_c \times EF_c \times AF_c \times SA_{soil-c} \times EV_{soil-c}}}{{BW_c}} + \frac{{ED_a \times EF_a \times AF_a \times SA_{soil-a} \times EV_{soil-a}}}{{BW_a}}$$

Source: Modified from RAGS, Vol. I, Part E, 2004.

where:

$RBTL_{doss-adj}$	=	Age-adjusted risk-based target level for dermal contact with soil [mg/kg-wet soil]
TR	=	Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
THQ	=	Target hazard quotient for individual constituents [-]
AT_c	=	Averaging time for carcinogens [year]
AT_{nc}	=	Averaging time for non-carcinogens [year]
EF_c	=	Exposure frequency for a child [day/year]
EF_a	=	Exposure frequency for an adult [day/year]
RAF_d	=	Dermal relative absorption factor [-]
AF_c	=	Resident child soil to skin adherence factor [mg/cm ² -event]
AF_a	=	Resident adult soil to skin adherence factor [mg/cm ² -event]
RfD_d	=	Chemical-specific dermal reference dose [(mg/kg-day)]
SF_d	=	Chemical-specific dermal cancer slope or potency factor [(mg/kg-day) ⁻¹]
SA_{aa}	=	Age-adjusted skin surface area [mg/ kg]
BW_c	=	Resident child body weight [kg]
BW_a	=	Resident adult body weight [kg]
ED_c	=	Resident child exposure duration [year]
ED_a	=	Resident adult exposure duration [year]
SA_{soil-c}	=	Resident child skin surface area available for contact with soil [cm ² /day]
SA_{soil-a}	=	Resident adult skin surface area available for contact with soil [cm ² /day]
EV_{soil-c}	=	Resident child event frequency [event/day]
EV_{soil-a}	=	Resident Child event frequency [event/day]
365	=	Conversion factor [day/year]
10^6	=	Conversion factor [kg/mg]

INGESTION OF CHEMICALS IN SOIL (AGE-ADJUSTED RESIDENT)

Carcinogenic effects

$$RBT_{ingss-adj} = \frac{TR \times AT_c \times 365}{SF_o \times IR_{s-aa} \times RAF_o \times 10^{-6}}$$

Non-carcinogenic effects

$$RBT_{ingss-adj} = \frac{THQ \times AT_{nc} \times 365 \times RfD_o}{IR_{s-aa} \times RAF_o \times 10^{-6}}$$

where :

$$IR_{s-aa} = \frac{ED_c \times EF_c \times IR_{s-c}}{BW_c} + \frac{ED_a \times EF_a \times IR_{s-a}}{BW_a}$$

Source: Modified from RAGS, Vol. I, Part A, 1989

where:

$RBT_{ingss-adj}$	= Risk-based target level for ingestion of soil [mg/kg-wet soil]
TR	= Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
THQ	= Target hazard quotient for individual constituents [-]
AT_c	= Averaging time for carcinogens [year]
AT_{nc}	= Averaging time for non-carcinogens [year]
RAF_o	= Oral relative absorption factor [-]
RfD_o	= Chemical-specific oral reference dose [mg/kg-day]
SF_o	= Chemical-specific oral cancer slope or potency factor [(mg/kg-day) ⁻¹]
IR_{s-aa}	= Age-adjusted soil ingestion rate [mg/kg]
IR_{s-c}	= Resident child soil ingestion rate [mg/day]
IR_{s-a}	= Resident adult soil ingestion rate [mg/day]
BW_c	= Resident child body weight [kg]
BW_a	= Resident adult body weight [kg]
ED_c	= Resident child exposure duration [year]
ED_a	= Resident adult exposure duration [year]
EF_c	= Exposure frequency for a child [day/year]
EF_a	= Exposure frequency for an adult [day/year]
365	= Conversion factor [day/year]
10^6	= Conversion factor [kg/mg]

**INHALATION OF VAPORS AND PARTICULATES OF CHEMICALS IN SOIL
(AGE-ADJUSTED RESIDENT)**

Carcinogenic effects

$$RBTL_{ss-adj} = \frac{TR \times AT_c \times 365}{IR_{ao-aa} \times SF_i \times (VF_{ss} + VF_p)}$$

Non-carcinogenic effects

$$RBTL_{ss-adj} = \frac{THQ \times AT_{nc} \times 365 \times RfD_i}{IR_{ao-aa} \times (VF_{ss} + VF_p)}$$

where:

$$IR_{ao-aa} = \frac{IR_{ao-c} \times ED_c \times EF_c \times ET_{o-c}}{BW_c} + \frac{IR_{ao-a} \times ED_a \times EF_a \times ET_{o-a}}{BW_a}$$

Note: $VF_{ss} = 0$ for non-volatile chemicals (i.e., chemicals with a molecular weight > 200 and Henry's law constant (dimensionless) < 4.2×10^{-4} or Henry's law constant (atm-m³/mol) < 1.5×10^{-5}).

Source: Modified from RAGS, Vol. I, Part B, 1991

where:

$RBTL_{ss-adj}$	= Age-adjusted risk-based target level in surficial soil [mg/kg]
TR	= Target risk or the increased chance of developing cancer over a lifetime due to exposure to a chemical [-]
THQ	= Target hazard quotient for individual constituents [-]
VF_{ss}	= Volatilization factor for vapor emissions from surficial soil[kg-soil/m ³ -air]
VF_p	= Volatilization factor for particulate emissions from surficial soil [kg-soil/m ³ -air]
IR_{ao-aa}	= Age-adjusted outdoor inhalation rate [m ³ /kg]
IR_{ao-c}	= Resident child outdoor inhalation rate [m ³ /hr]
IR_{ao-a}	= Resident adult outdoor inhalation rate [m ³ /hr]
AT_c	= Averaging time for carcinogens [year]
AT_{nc}	= Averaging time for non-carcinogens [year]
ED_c	= Exposure duration for child [year]
ED_a	= Exposure duration for an adult [year]
EF_c	= Exposure frequency for a child [day/year]
EF_a	= Exposure frequency for an adult [day/year]
ET_{o-c}	= Outdoor exposure time for a child [hour/day]
ET_{o-a}	= Outdoor exposure time for an adult [hour/day]
RfD_i	= Chemical-specific inhalation reference dose [mg/kg-day]
SF_i	= Chemical-specific inhalation cancer slope factor [(mg/kg-day) ⁻¹]
365	= Conversion factor [day/year]

INHALATION OF VAPORS AND PARTICULATES, DERMAL CONTACT WITH, AND INGESTION OF CHEMICALS IN SOIL (AGE-ADJUSTED RESIDENT)

Carcinogenic effects

$$RBTL_{ss-combined} = \frac{TR \times AT_c \times 365}{(SF_o \times 10^{-6} \times IR_{s-aa} \times RAF_o) + (SF_d \times 10^{-6} \times SA_{soil-aa} \times RAF_d) + SF_i \times IR_{ao-aa} \times (VF_{ss} + VF_p)}$$

Non-carcinogenic effects

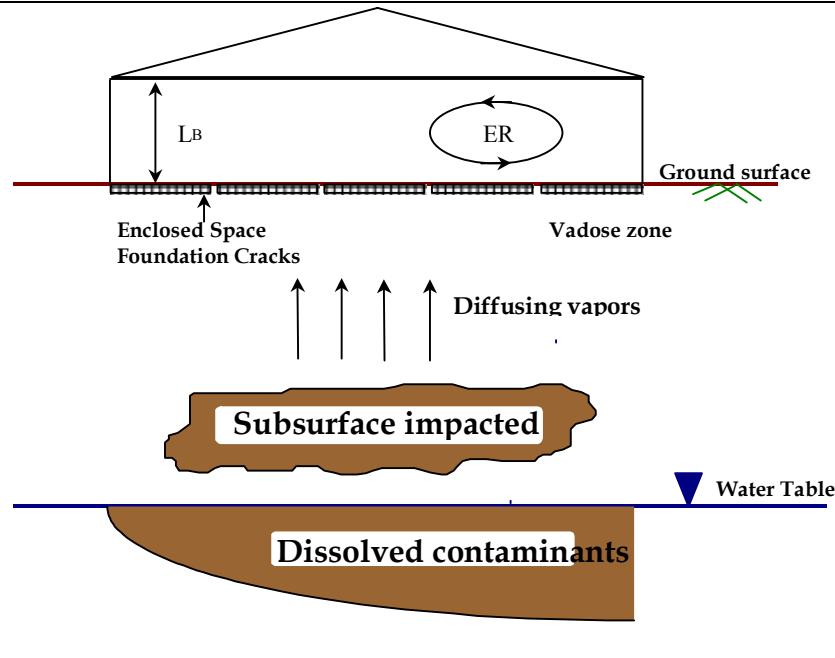
$$RBTL_{ss-combined} = \frac{THQ \times AT_{nc} \times 365}{\frac{1}{RfD_o} \times 10^{-6} \times IR_{s-aa} \times RAF_o + \frac{1}{RfD_d} \times 10^{-6} \times SA_{soil-aa} \times RAF_d + \frac{1}{RfD_i} \times IR_{ao-aa} \times (VF_{ss} + VF_p)}$$

Note: All parameters are defined under the individual pathway equations.

Note: $VF_{ss} = 0$ for non-volatile chemicals (i.e., chemicals with a molecular weight > 200 and Henry's law constant (dimensionless) < 4.2×10^{-4} or Henry's law constant (atm-m³/mol) < 1.5×10^{-5}).

Source: Modified from RAGS, Vol. I, Part E, 2004.

SUBSURFACE SOIL VAPOR CONCENTRATIONS PROTECTIVE OF INDOOR VAPOR INHALATION



$$RBTL_{svi} = \frac{RBTL_{ai}}{VF_{sv}}$$

where:

- $RBTL_{svi}$ = Risk-based target level for indoor inhalation of vapors from subsurface [mg/m³-air]
- $RBTL_{ai}$ = Risk-based target level for indoor inhalation of air [mg/m³-air]
- VF_{sv} = Volatilization factor from subsurface soil vapor to indoor (enclosed space) air [-]

Source: ASTM E1739-95

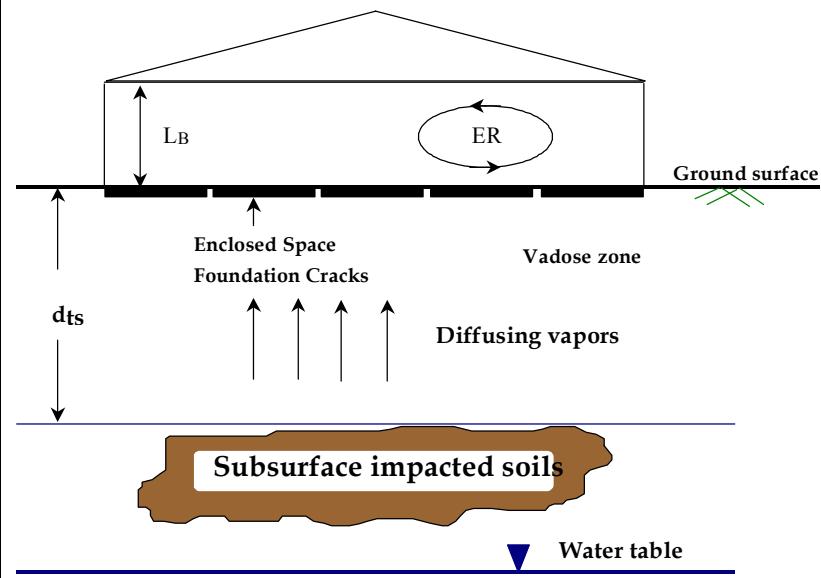
SUBSURFACE SOIL CONCENTRATIONS PROTECTIVE OF INDOOR VAPOR INHALATION

$$RBTL_{si} = \frac{RBTL_{ai}}{VF_{sesp}}$$

where:

- $RBTL_{si}$ = Risk-based target level for indoor inhalation of vapors from subsurface soils [mg/kg-soil]
- $RBTL_{ai}$ = Risk-based target level for indoor inhalation of air [mg/m³-air]
- VF_{sesp} = Volatilization factor from subsurface soil to indoor (enclosed space) air [(mg/m³-air)/(mg/kg-soil)]

Source: ASTM E1739-95



GROUNDWATER CONCENTRATIONS PROTECTIVE OF INDOOR VAPOR INHALATION

$$RBTL_{wi} = \frac{RBTL_{ai}}{VF_{wesp}}$$

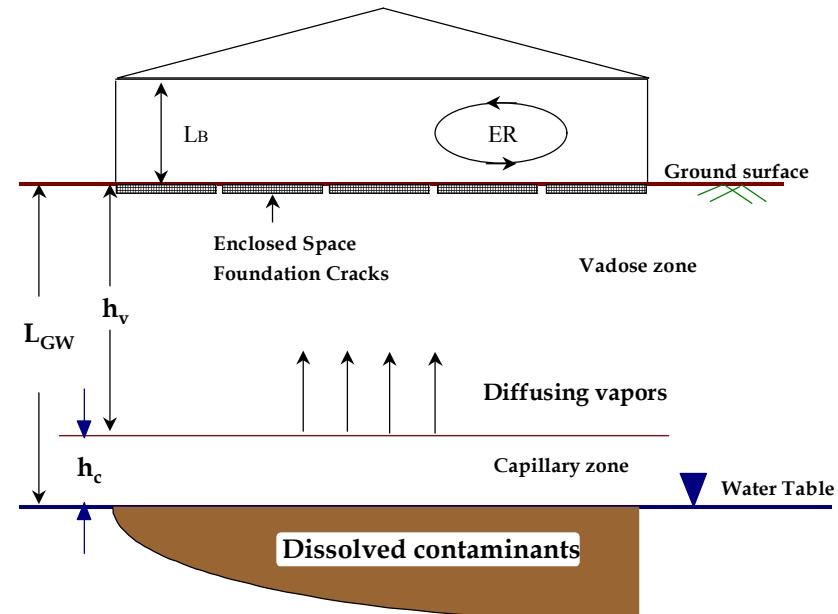
where:

$RBTL_{wi}$ = Risk-based target level for indoor inhalation of vapors from groundwater [mg/L-water]

$RBTL_{ai}$ = Risk-based target level for indoor inhalation of air (mg/m³-air)

VF_{wesp} = Volatilization factor from groundwater to indoor (enclosed space) air [(mg/m³-air)/(mg/L-water)]

Source: ASTM E1739-95



GROUNDWATER CONCENTRATIONS PROTECTIVE OF OUTDOOR VAPOR INHALATION

$$RBTL_{wi} = \frac{RBTL_{ao}}{VF_{wamb}}$$

where:

- $RBTL_{wi}$ = Risk-based target level for indoor inhalation of vapors from groundwater [mg/L-water]
 $RBTL_{ao}$ = Risk-based target level for outdoor inhalation of air (mg/m³-air)
 VF_{wamb} = Volatilization factor from groundwater to outdoor air [(mg/m³-air)/(mg/L-water)]

Source: ASTM E1739-95

VOLATILIZATION FACTORS (SURFICIAL SOIL TO OUTDOOR AIR)

$$VF_{ss} = \left[Q/C \times \frac{(3.14 \times D_A \times \tau)^{1/2}}{(2 \times \rho_s \times D_A)} \times 10^{-4} \right]^{-1}$$

where:

$$D_A = \frac{(\theta_{as}^{10/3} \times D^a \times H + \theta_{ws}^{10/3} \times D^w) / \theta_T^2}{\rho_s \times K_{sv} + \theta_{ws} + \theta_{as} \times H}$$

or

$$VF_{ss} = \frac{W_a \times \rho_s \times d_s}{U_m \times \delta_a \times \tau} \times 10^3$$

Use smaller of the two VF_{ss} .

Source: Soil Screening Guidance, 1996

where:

VF_{ss}	= Volatilization factor from surficial soil to outdoor (ambient) air [kg-soil/m ³ -air]
Q/C	= Inverse of the mean concentration at the center of square source [(g/m ² -s)/(kg/m ³)]
D_A	= Apparent diffusivity [cm ² /s]
τ	= Averaging time for vapor flux [s]
ρ_s	= Vadose zone dry soil bulk density of surficial soil [g-soil/cm ³ -soil]
K_{sv}	= Chemical-specific solid-water sorption coefficient [cm ³ -water/g-soil]
D_a	= Chemical-specific diffusion coefficient in air [cm ² /s]
D_w	= Chemical-specific diffusion coefficient in water [cm ² /s]
θ_T	= Total soil porosity in the surficial soils [cm ³ /cm ³ -soil]
θ_{as}	= Volumetric air content in the surficial soils [cm ³ -air/cm ³ -soil]
θ_{ws}	= Volumetric water content in the surficial soils [cm ³ -water/cm ³ -soil]
H	= Chemical-specific Henry's Law constant [(L-water)/(L-air)]
10^4	= Conversion factor [m ² /cm ²]
W_a	= Dimension of soil source area parallel to wind direction [cm]
d_s	= Depth to base of surficial soil zone [cm]
U_m	= Mean annual wind speed [m/s]
δ_a	= Breathing zone height [cm]
10^3	= Conversion factor [(cm ³ -kg)/(m ³ -g)]

Note: Surficial soil properties are assumed same as the vadose zone properties.

**VOLATILIZATION FACTORS
(PARTICULAR EMISSIONS FROM SURFICIAL SOIL)**

$$VF_p = \left[Q/C \times \frac{3600}{0.036 \times (1 - V) \times (U_m/U_t)^3 \times F(x)} \right]^{-1}$$

where:

- VF_p = Volatilization factor for particulate emissions from surficial soil [kg-soil/m³-air]
- Q/C = Inverse of the mean concentration at the center of square source [(g/m²-s)/(kg/m³)]
- V = Fraction of vegetative cover [-]
- U_m = Mean annual wind speed [m/s]
- U_t = Equivalent threshold value of wind speed at 7 m [m/s]
- $F(x)$ = Function dependent on U_m/U_t derived using Cowherd *et al.* 1985 [-]
- 0.036 = Empirical constant [g/m²-hr]

Source: Soil Screening Guidance, 1996

**VOLATILIZATION FACTORS
(SUBSURFACE SOIL VAPOR TO INDOOR AIR)**

$$VF_{sv} = \frac{\left[\frac{D_s^{eff} / d_{sv}}{ER \times L_B} \right]}{1 + \left[\frac{D_s^{eff} / d_{sv}}{ER \times L_B} \right] + \left[\frac{D_s^{eff} / d_{sv}}{(D_{crack}^{eff} / L_{crack}) \times \eta} \right]}$$

Source: ASTM E1739-95

where:

- VF_{sv} = Volatilization factor from subsurface soil vapor to indoor (enclosed space) air [-]
- θ_{ws} = Volumetric water content in vadose zone soils [$\text{cm}^3\text{-water}/\text{cm}^3\text{-soil}$]
- θ_{as} = Volumetric air content in vadose zone soils [$\text{cm}^3\text{-air}/\text{cm}^3\text{-soil}$]
- d_{sv} = Depth to subsurface soil vapor samples taken [cm]
- L_B = Enclosed space volume/infiltration area ratio [cm]
- L_{crack} = Enclosed space foundation or wall thickness [cm]
- ER = Enclosed space air exchange rate [1/s]
- D_s^{eff} = Effective diffusion coefficient in soil based on vapor-phase concentration [cm^2/s]
- D_{crack}^{eff} = Effective diffusion coefficient through foundation cracks [cm^2/s]
- η = Area fraction of cracks in foundation and/or walls [$\text{cm}^2\text{-cracks}/\text{cm}^2\text{-total area}$]

VOLATILIZATION FACTORS (SUBSURFACE SOIL TO INDOOR AIR)

$$VF_{\text{sesp}} = \frac{\frac{H \times \rho_s}{[\theta_{ws} + (K_{sv} \times \rho_s) + (H \times \theta_{as})]} \times \left[\frac{D_s^{\text{eff}} / d_{ts}}{ER \times L_B} \right]}{1 + \left[\frac{D_s^{\text{eff}} / d_{ts}}{ER \times L_B} \right] + \left[\frac{D_s^{\text{eff}} / d_{ts}}{(D_{\text{crack}}^{\text{eff}} / L_{\text{crack}}) \times \eta} \right]} \times 10^3$$

Source: ASTM E1739-95

where:

VF_{sesp}	= Volatilization factor from subsurface soil to indoor (enclosed space) air [$\text{m}^3\text{-air}/(\text{mg/kg-soil})$]
H	= Chemical-specific Henry's Law constant [L-water/L-air]
ρ_s	= Dry soil bulk density [$\text{g-soil/cm}^3\text{-soil}$]
θ_{ws}	= Volumetric water content in vadose zone soils [$\text{cm}^3\text{-water/cm}^3\text{-soil}$]
K_{sv}	$f_{ocv} \times K_{oc}$
	= Chemical-specific soil-water sorption coefficient in vadose zone [$\text{cm}^3\text{-water/g-soil}$]
θ_{as}	= Volumetric air content in vadose zone soils [$\text{cm}^3\text{-air/cm}^3\text{-soil}$]
d_{ts}	= Depth to subsurface soil sources [cm]
L_B	= Enclosed space volume/infiltration area ratio [cm]
L_{crack}	= Enclosed space foundation or wall thickness [cm]
ER	= Enclosed space air exchange rate [1/s]
D_s^{eff}	= Effective diffusion coefficient in soil based on vapor-phase concentration [cm^2/s]
$D_{\text{crack}}^{\text{eff}}$	= Effective diffusion coefficient through foundation cracks [cm^2/s]
η	= Area fraction of cracks in foundation and/or walls [$\text{cm}^2\text{-cracks/cm}^2\text{-total area}$]
10^3	= Conversion factor [$(\text{cm}^3\text{-kg})/(\text{m}^3\text{-g})$]

**VOLATILIZATION FACTORS
(GROUNDWATER TO INDOOR AIR)**

$$VF_{wesp} = \frac{H \times \left[\frac{D_{ws}^{eff} / L_{GW}}{ER \times L_B} \right]}{1 + \left[\frac{D_{ws}^{eff} / L_{GW}}{ER \times L_B} \right] + \left[\frac{D_{ws}^{eff} / L_{GW}}{(D_{crack}^{eff} / L_{crack}) \times \eta} \right]} \times 10^3$$

Source: ASTM E1739-95

where:

VF_{wesp}	= Volatilization factor from groundwater to indoor (enclosed space) air [(mg/m ³ -air)/(mg/L-water)]
H	= Vadose zone chemical specific Henry's Law constant [(L-water)/(L-air)]
L_{GW}	= Depth to groundwater [cm]
L_B	= Enclosed space volume/infiltration area ratio [cm]
L_{crack}	= Enclosed space foundation or wall thickness [cm]
ER	= Enclosed space air exchange rate [1/s]
D_{ws}^{eff}	= Effective diffusion coefficient between groundwater and soil surface [cm ² /s]
D_{crack}^{eff}	= Effective diffusion coefficient through foundation cracks [cm ² /s]
η	= Area fraction of cracks in foundation and/or walls [cm ² -cracks/ cm ² -total area]
10^3	= Conversion factor [L/m ³]

**VOLATILIZATION FACTORS
(GROUNDWATER TO OUTDOOR AIR)**

$$VF_{wamb} = \frac{H}{1 + \left(\frac{100 \times U_m \times \delta_a \times L_{GW}}{W_{ga} \times D_{ws}^{eff}} \right)} \times 10^3$$

where:

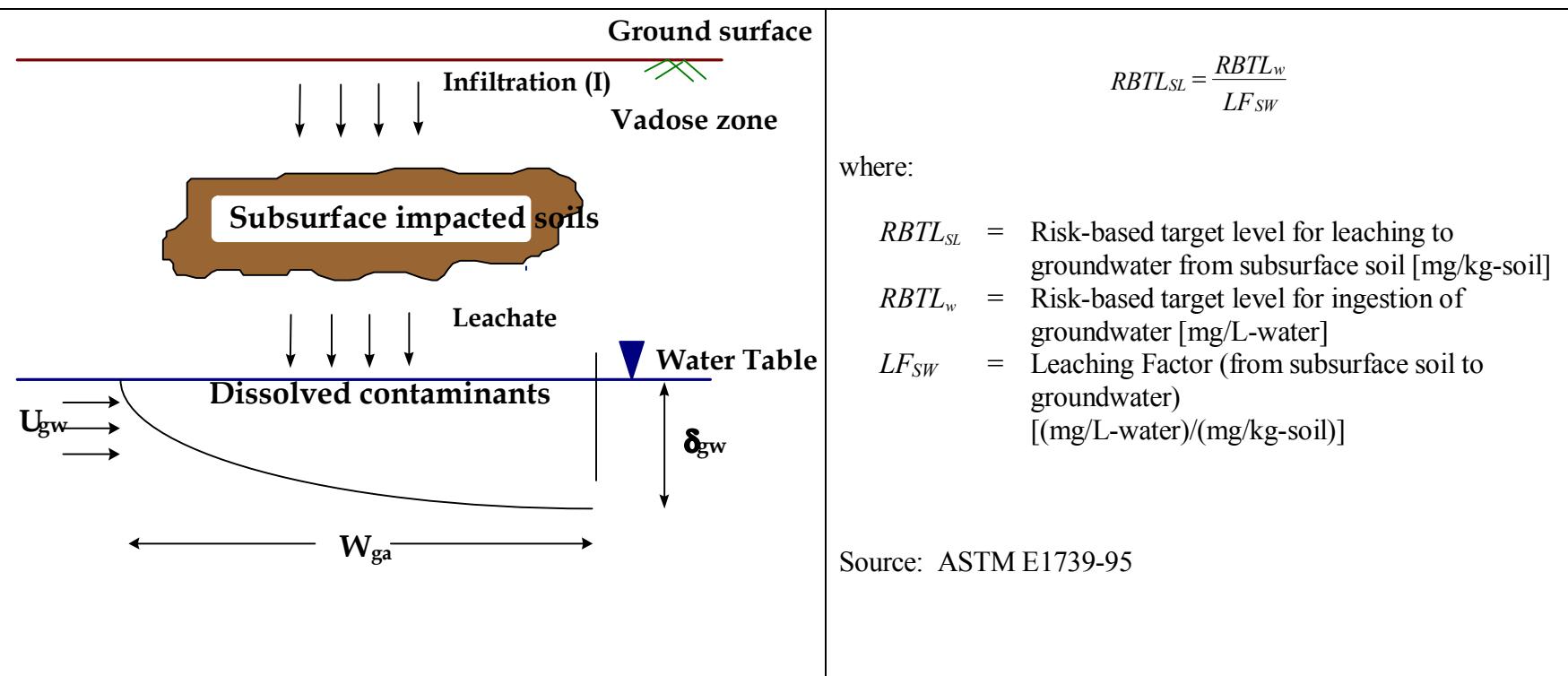
VF_{wamb}	= Volatilization factor from groundwater to outdoor air [(mg/m ³ -air)/(mg/L-water)]
H	= Vadose zone chemical specific Henry's Law constant [(L-water)/(L-air)]
U_m	= Mean annual wind speed [m/s]
δ_a	= Breathing zone height [cm]
L_{GW}	= Depth to groundwater [cm]
D_{ws}^{eff}	= Effective diffusion coefficient between groundwater and soil surface [cm ² /s]
W_{ga}	= Dimension of soil source area parallel to wind direction [cm]
100	= Conversion factor [cm/m]
10^3	= Conversion factor [L/m ³]

Source: ASTM E1739-95

EFFECTIVE DIFFUSION COEFFICIENTS	
<p>D_s^{eff} : effective diffusion coefficient in soil based on vapor-phase concentration [cm²/s]</p> $D_s^{eff} = D^a \times \frac{\theta_{as}^{3.33}}{\theta_T^2} + D^w \times \frac{I}{H} \times \frac{\theta_{ws}^{3.33}}{\theta_T^2}$ <p>where:</p> <ul style="list-style-type: none"> D^a = Chemical-specific diffusion coefficient in air [cm²/s] D^w = Chemical-specific diffusion coefficient in water [cm²/s] θ_{as} = Volumetric air content in vadose zone soils [cm³-air/cm³-soil] θ_{ws} = Volumetric water content in vadose zone soils [cm³-water/cm³-soil] θ_T = Total soil porosity in the impacted zone [cm³/cm³-soil] H = Chemical-specific Henry's Law constant [L-water/L-air] 	<p>D_{ws}^{eff} : effective diffusion coefficient between groundwater and surface soil [cm²/s]</p> $D_{ws}^{eff} = (h_{cap} + h_v) \times \left[\frac{h_{cap}}{D_{cap}^{eff}} + \frac{h_v}{D_s^{eff}} \right]^{-1}$ <p>where:</p> <ul style="list-style-type: none"> h_{cap} = Thickness of capillary fringe [cm] h_v = Thickness of vadose zone [cm] D_{cap}^{eff} = Effective diffusion coefficient through capillary fringe [cm²/s] D_s^{eff} = Effective diffusion coefficient in soil based on vapor-phase concentration [cm²/s] L_{GW} = Depth to groundwater ($h_{cap} + h_v$) [cm]
<p>D_{cap}^{eff} : effective diffusion coefficient for the capillary fringe [cm²/s]</p> $D_{cap}^{eff} = D^a \times \frac{\theta_{acap}^{3.33}}{\theta_T^2} + D^w \times \frac{I}{H} \times \frac{\theta_{wcap}^{3.33}}{\theta_T^2}$ <p>where:</p> <ul style="list-style-type: none"> D^a = Chemical-specific diffusion coefficient in air [cm²/s] D^w = Chemical-specific diffusion coefficient in water [cm²/s] θ_{acap} = Volumetric air content in capillary fringe soils [cm³-air/cm³-soil] θ_{wcap} = Volumetric water content in capillary fringe soils [cm³-water/cm³-soil] θ_T = Total soil porosity [cm³/cm³-soil] H = Chemical-specific Henry's Law constant [L-water/L-air] 	<p>D_{crack}^{eff} : effective diffusion coeff. through foundation cracks [cm²/s]</p> $D_{crack}^{eff} = D^a \times \frac{\theta_{acrack}^{3.33}}{\theta_T^2} + D^w \times \frac{I}{H} \times \frac{\theta_{wcrack}^{3.33}}{\theta_T^2}$ <p>where:</p> <ul style="list-style-type: none"> D^a = Chemical-specific diffusion coefficient in air [cm²/s] D^w = Chemical-specific diffusion coefficient in water [cm²/s] θ_{acrack} = Volumetric air content in foundation/wall cracks [cm³-air/cm³-total volume] θ_{wcrack} = Volumetric water content in foundation/wall cracks [cm³-water/cm³-total volume] θ_T = Total soil porosity [cm³/cm³-soil] H = Chemical-specific Henry's Law constant [L-water/L-air]

Source: ASTM E1739-95

SUBSURFACE SOIL CONCENTRATIONS PROTECTIVE OF LEACHING TO GROUNDWATER



LEACHING FACTOR FROM SUBSURFACE SOIL TO GROUNDWATER

$$LF_{SW} = \frac{\rho_s}{[\theta_{ws} + K_{sv} \times \rho_s + H \times \theta_{as}] \times \left(1 + \frac{U_{gw} \times \delta_{gw}}{I \times W_{ga}} \right)}$$

where:

- LF_{SW} = Leaching factor from subsurface soil to groundwater [(mg/L-water)/(mg/kg-soil)]
- ρ_s = Vadose zone dry soil bulk density [g-soil/cm³-soil]
- θ_{ws} = Volumetric water content in vadose zone soils [cm³-water/cm³- soil]
- K_{sv} = $f_{ocv} \times K_{oc}$ = Chemical-specific soil-water sorption coefficient in vadose zone [cm³-water/g-soil]
- H = Chemical-specific Henry's Law constant [L-water/L-air]
- θ_{as} = Volumetric air content in the vadose zone soils [cm³-air/cm³-soil]
- U_{gw} = K_i = Groundwater Darcy velocity [cm/yr]
- K = Hydraulic conductivity of the saturated zone [cm/year]
- i = Hydraulic gradient in the saturated zone [-]
- δ_{gw} = Groundwater mixing zone thickness [cm]
- I = Infiltration rate of water through vadose zone [cm/year]
- W_{ga} = Groundwater dimension parallel to groundwater flow direction [cm]

This equation consists of two parts (i) the Summer's model and (ii) equilibrium conversion of the leachate concentration to a soil concentration on a dry weight basis.

Source: ASTM E1739-95

SOIL CONCENTRATION AT WHICH DISSOLVED PORE WATER AND VAPOR PHASES BECOME SATURATED

Single Component

$$C_s^{SAT} = \frac{S}{\rho_s} \times [H \times \theta_{as} + \theta_{ws} + K_{sv} \times \rho_s]$$

Multiple Components

$$C_s^{SAT} = \frac{S_{ei}}{\rho_s} \times [H \times \theta_{as} + \theta_{ws} + K_{sv} \times \rho_s]$$

where:

- C_s^{SAT} = Soil concentration at which dissolved pore water and vapor phases become saturated [(mg/kg-soil)]
 S = Pure component solubility in water [mg/L-water]
 S_{ei} = Effective solubility of component i in water = $x_i \times S$ [mg/L-water]
 x_i = Mole fraction of component i = $(w_i \times MW_{avg})/MW_i$ [-]
 w_i = Weight fraction of component i [-]
 MW_{avg} = Average molecular weight of mixture [g/mole]
 MW_i = Molecular weight of component i [g/mole]
 ρ_s = Vadose zone dry soil bulk density [g-soil/cm³-soil]
 H = Chemical-specific Henry's Law constant [L-water/L-air]
 θ_{as} = Volumetric air content in the vadose zone soils [cm³-air/cm³-soil]
 θ_{ws} = Volumetric water content in vadose zone soils [cm³-water/cm³- soil]
 K_{sv} = $f_{ocv} \times K_{oc}$ = Chemical-specific soil-water sorption coefficient in vadose zone [cm³-water/g-soil]
 f_{ocv} = Fraction organic carbon in vadose zone [g-C/g-soil]

Source: ASTM E1739-95

SOIL VAPOR CONCENTRATION AT WHICH VAPOR PHASE BECOMES SATURATED

Single Component

$$C_v^{SAT} = \frac{P^s \times MW}{R \times T} \times 10^6$$

Multiple Components

$$C_v^{SAT} = \frac{x_i \times P_i^s \times MW_i}{R \times T} \times 10^6$$

where:

- C_v^{SAT} = Soil vapor concentration at which vapor phase become saturated [mg/m³-air]
 P^s = Saturated vapor pressure [atm]
 P_i^s = Effective vapor pressure of component i in water = $x_i \times P^s$ [atm]
 R = Ideal gas constant [0.08206 atm•L/mol•K]
 T = Temperature [K]
 S_{ei} = Effective solubility of component i in water = $x_i \times S$ [mg/L-water]
 x_i = Mole fraction of component i = $(w_i \times MW_{avg})/MW_i$ [-]
 w_i = Weight fraction of component i [-]
 MW_{avg} = Average molecular weight of mixture [g/mole]
 MW_i = Molecular weight of component i [g/mole]
 ρ_s = Vadose zone dry soil bulk density [g-soil/cm³-soil]
 10^6 = Conversion factor [(g/L)/(mg/m³)]

Source: ASTM E1739-95

DOMENICO MODEL: DILUTION ATTENUATION FACTOR (DAF) IN THE SATURATED ZONE

Domenico model for multi-dimensional transport with decay and continuous source:

$$\frac{C(x,y,z,t)}{C_o} = (1/8) \exp\left[\frac{x}{2\alpha_x}\left[1 - \sqrt{1 + \frac{4\lambda\alpha_x}{v}}\right]\right] \times \operatorname{erfc}\left[\frac{(x-vt)\sqrt{1 + \frac{4\lambda\alpha_x}{v}}}{2\sqrt{\alpha_x \times v \times t}}\right] \times \\ \left[\operatorname{erf}\left[\frac{(y+Y/2)}{2\sqrt{\alpha_y x}}\right] - \operatorname{erf}\left[\frac{(y-Y/2)}{2\sqrt{\alpha_y x}}\right] \right] \times \left[\operatorname{erf}\left[\frac{(z+Z)}{2\sqrt{\alpha_z x}}\right] - \operatorname{erf}\left[\frac{(z-Z)}{2\sqrt{\alpha_z x}}\right] \right]$$

where:

- C = Dissolved-phase concentration [mg/L]
- C_o = Dissolved-phase concentration at the source (at $x=y=z=0$) [mg/L]
- v = Retarded seepage velocity [m/sec]
- λ = Overall first order bio-decay rate [1/day]
- α_x = Longitudinal dispersivity [m]
- α_y = Lateral dispersivity [m]
- α_z = Vertical dispersivity [m]
- x, y, z = Spatial coordinates [m]
- t = Time [day]
- x = Distance along the centerline measured from the downgradient edge of the groundwater source [m]
- Y = GW source dimension perpendicular to GW flow direction [m]
- Z = GW source (mixing zone) thickness [m]
- $DA F_{sat}$ = $C_o/C(x)$

At the centerline, for steady-state (after a long time) the concentration can be obtained by setting $y = 0, z = 0$, and $x \ll v \times t$ as:

$$\frac{C(x)}{C_o} = \exp\left[\frac{x}{2\alpha_x}\left[1 - \sqrt{1 + \frac{4\lambda\alpha_x}{v}}\right]\right] \times \\ \operatorname{erf}\left[\frac{Y}{4\sqrt{\alpha_y x}}\right] \times \operatorname{erf}\left[\frac{Z}{2\sqrt{\alpha_z x}}\right]$$

At the centerline, for steady-state the concentration without decay can be obtained by setting $y = 0, z = 0$, $x \ll vt$, and $\lambda = 0$ as:

$$\frac{C(x)}{C_o} = \operatorname{erf}\left[\frac{Y}{4\sqrt{\alpha_y x}}\right] \times \operatorname{erf}\left[\frac{Z}{2\sqrt{\alpha_z x}}\right]$$

Note: Compare to ASTM E1739-95, p. 31, where $Y = S_w Z = S_d$, $v = u$, and $C_o = C_{source}$

Source: Domenico, P.A. and F.W. Schwartz, 1990, Physical and Chemical Hydrogeology. John Wiley and Sons, NY, 824 p. (Eqn. 17.21)

ALLOWABLE SOIL AND GROUNDWATER CONCENTRATION FOR GROUNDWATER RESOURCE PROTECTION

Allowable soil concentration at the source [mg/kg] = Target groundwater concentration at the POE $\times \frac{DAF_{POE}}{LF_{SW}} \times DAF_{unsat}$

Allowable groundwater concentration at the POD [mg/L] = Target groundwater concentration at the POE $\times \frac{DAF_{POE}}{DAF_{POD}}$

where:

POE = Point of exposure

POD = Point of demonstration

DAF_{POE} = Dilution attenuation factor between the point of exposure and source estimated using Domenico's equation

DAF_{POD} = Dilution attenuation factor between the point of demonstration and source estimated using Domenico's equation

DAF_{unsat} = Dilution attenuation factor in the unsaturated zone

LF_{SW} = Dry soil leaching factor [(mg/L-water)/(mg/kg-soil)]

Concentration at POE is expressed in mg/L-water. Additional relationships used in the calculation of allowable soil and groundwater concentration with chemical degradation:

$$\text{First order decay rate [1/day]} = \frac{0.693}{\text{Half Life}}; \quad v = \frac{Ki}{\theta_{TS} R_s}$$

$$\text{Retardation factor for organics in the saturated zone } (R_s) = 1 + \left(\frac{\rho_{ss} \times K_{ss}}{\theta_{TS}} \right), \quad K_{ss} = f_{ocs} \times K_{oc} \text{ (for organics only)}$$

where:

v = Regarded seepage velocity [cm/year]

K = Hydraulic conductivity in saturated zone [cm/year]

i = Hydraulic gradient in saturated zone [-]

ρ_{ss} = Saturated zone dry soil bulk density [g-soil/cm³-soil]

K_{ss} = Chemical-specific soil-water sorption coefficient in the saturated zone [cm³-water/g-soil]

K_{oc} = Chemical-specific normalized partition coefficient [cm³/g-C]

θ_{TS} = Total porosity in the saturated zone [cm³/g-C]

f_{ocs} = Fractional organic carbon content in the saturated zone [g-C/g-soil]

ALLOWABLE SOIL AND GROUNDWATER CONCENTRATION PROTECTIVE OF INDOOR INHALATION FOR RESIDENT AND NON-RESIDENTIAL WORKER

Allowable soil concentration at the source [mg/kg] = Target groundwater concentration below on/off - site building $\times \frac{DAF_{bldg}}{LF_{SW}} \times DAF_{unsat}$

Allowable groundwater concentration at the POD [mg/L] = Target groundwater concentration below on/off - site building $\times \frac{DAF_{bldg}}{DAF_{POD}}$

where:

POD = Point of demonstration

DAF_{bldg} = Dilution attenuation factor between the on/off-site building and source estimated using Domenico's equation

DAF_{POD} = Dilution attenuation factor between the point of demonstration and source estimated using Domenico's equation

DAF_{unsat} = Dilution attenuation factor in the unsaturated zone

LF_{SW} = Dry soil leaching factor [(mg/L-water)/(mg/kg-soil)]

Concentration below on/off-site building is expressed in mg/L-water

STREAM PROTECTION: ALLOWABLE GROUNDWATER CONCENTRATION AT THE POINT OF DISCHARGE

$$C_{gw} = \frac{C_{sw}(Q_{gw} + Q_{sw})}{Q_{gw}} - C_{su}\left(\frac{Q_{sw}}{Q_{gw}}\right)$$

$$Q_{gw} = (Z + \sqrt{\alpha_z X_s}) \times (Y + 2\sqrt{\alpha_y X_s}) \times U_{gw}$$

where:

Q_{gw}	=	Impacted groundwater discharge into the stream [ft ³ /day]
C_{gw}	=	Allowable concentration in groundwater at the point of discharge into the stream [mg/L]
Q_{sw}	=	Stream flow upstream of the point of groundwater discharge (stream flow rate) [ft ³ /day]
C_{sw}	=	Allowable concentration at the downstream edge of the stream's mixing zone, i.e., the applicable stream water quality criteria [mg/L]
C_{su}	=	The COCs' concentration upstream of the groundwater plume discharge [mg/L]
Y	=	GW source dimension perpendicular to GW flow direction [ft]
Z	=	GW source (mixing zone) thickness [ft]
α_y	=	Lateral dispersivity [ft]
α_z	=	Vertical dispersivity [ft]
X_s	=	Distance from the downgradient edge of the groundwater source to the stream [ft]
U_{gw}	=	Darcy velocity [ft/day]

STREAM PROTECTION: ALLOWABLE SOIL AND GROUNDWATER CONCENTRATION AT THE SOURCE & POD

Allowable soil concentration at the source [mg/kg] = Target concentration at the POE [mg/L] $\times \frac{DAF_{POE}}{LF_{SW}} \times DAF_{unsat}$

Allowable groundwater concentration at the POD [mg/L] = Target concentration at the POE [mg/L] $\times \frac{DAF_{POE}}{DAF_{POD}}$

where:

POE = Point of exposure

POD = Point of demonstration

DAF_{POE} = Dilution attenuation factor between the point of exposure and source estimated using Domenico's equation

DAF_{POD} = Dilution attenuation factor between the point of demonstration and the source estimated using Domenico's equation

DAF_{unsat} = Dilution attenuation factor in the unsaturated zone

LF_{SW} = Dry soil leaching factor [(mg/L-water)/(mg/kg-soil)]

For calculation of DAF_{POE} and DAF_{POD} , please refer to Domenico's model.

Table E-1
Toxicity Values of Chemicals

Chemicals	CAS #	Slope Factor			Reference Dose			Absorption Factor		
		Oral, SF _o (mg/kg-day) ⁻¹	Inhalation, SF _i (mg/kg-day) ⁻¹	Dermal, SF _d (mg/kg-day) ⁻¹	Oral, RfD _o (mg/kg-day)	Inhalation, RfD _i (mg/kg-day)	Dermal, RfD _d (mg/kg-day)	Dermal, RAF _d (unitless)	Oral, RAF _o (unitless)	
VOCs and SVOCs										
Acenaphthene	83-32-9	NA	NA	NA	6.0E-02	<i>i</i>	6.0E-02	<i>r</i>	6.0E-02	0.13 <i>RE</i> 1.0
Acenaphthylene	208-96-8	NA	NA	NA	6.0E-02	<i>t</i>	6.0E-02	<i>r</i>	6.0E-02	N/A <i>RE</i> 1.0
Acetone	67-64-1	NA	NA	NA	9.0E-01	<i>i</i>	9.0E-01	<i>r</i>	9.0E-01	N/A <i>RE</i> 1.0
Acetonitrile	75-05-8	NA	NA	NA	1.7E-02	<i>r</i>	1.7E-02	<i>i</i>	1.7E-02	N/A <i>RE</i> 1.0
Acrylamide	79-06-1	4.5E+00	<i>i</i>	4.5E+00	<i>i</i>	4.5E+00	2.0E-04	<i>i</i>	2.0E-04	<i>r</i> 0.1 <i>RE</i> 1.0
Acrylic acid	79-10-7	NA	NA	NA	5.0E-01	<i>i</i>	2.9E-04	<i>i</i>	5.0E-01	0.1 <i>RE</i> 1.0
Acrylonitrile	107-13-1	5.4E-01	<i>i</i>	2.4E-01	<i>i</i>	5.4E-01	1.0E-03	<i>t</i>	5.7E-04	<i>i</i> 1.0E-03 N/A <i>RE</i> 1.0
Allyl alcohol	107-18-6	NA	NA	NA	5.0E-03	<i>i</i>	5.0E-03	<i>r</i>	5.0E-03	0.1 <i>RE</i> 1.0
Allyl chloride	107-05-1	2.1E-02	<i>c</i>	2.1E-02	<i>c</i>	2.1E-02	2.9E-04	<i>r</i>	2.9E-04	<i>i</i> 0.1 <i>RE</i> 1.0
Aniline	62-53-3	5.7E-03	<i>i</i>	5.7E-03	<i>c</i>	5.7E-03	7.0E-03	<i>p</i>	2.9E-04	<i>i</i> 7.0E-03 0.1 <i>RE</i> 1.0
Anthracene	120-12-7	NA	NA	NA	3.0E-01	<i>i</i>	3.0E-01	<i>r</i>	3.0E-01	0.13 <i>RE</i> 1.0
Aroclor 1016	12674-11-2	7.0E-02	<i>a</i>	7.0E-02	<i>a</i>	7.0E-02	7.0E-05	<i>i</i>	7.0E-05	<i>r</i> 0.14 <i>RE</i> 1.0
Aroclor 1221	11104-28-2	2.0E+00	<i>a</i>	2.0E+00	<i>a</i>	2.0E+00	2.0E-05	<i>a</i>	2.0E-05	<i>a</i> 0.14 <i>RE</i> 1.0
Aroclor 1242	53469-21-9	2.0E+00	<i>a</i>	2.0E+00	<i>a</i>	2.0E+00	2.0E-05	<i>a</i>	2.0E-05	<i>a</i> 0.14 <i>RE</i> 1.0
Aroclor 1248	12672-29-6	2.0E+00	<i>a</i>	2.0E+00	<i>a</i>	2.0E+00	2.0E-05	<i>a</i>	2.0E-05	<i>a</i> 0.14 <i>RE</i> 1.0
Aroclor 1254	11097-69-1	2.0E+00	<i>a</i>	2.0E+00	<i>a</i>	2.0E+00	2.0E-05	<i>i</i>	2.0E-05	<i>r</i> 2.0E-05 0.14 <i>RE</i> 1.0
Aroclor 1260	11096-82-5	2.0E+00	<i>a</i>	2.0E+00	<i>a</i>	2.0E+00	2.0E-05	<i>a</i>	2.0E-05	<i>a</i> 2.0E-05 0.14 <i>RE</i> 1.0
Azobenzene	103-33-3	1.1E-01	<i>i</i>	1.1E-01	<i>i</i>	1.1E-01	NA	NA	NA	N/A <i>RE</i> 1.0
Benzene	71-43-2	3.5E-02	<i>m</i>	1.8E-02	<i>m</i>	3.5E-02	4.0E-03	<i>i</i>	8.6E-03	<i>i</i> 4.0E-03 N/A <i>RE</i> 1.0
Benzidine	92-87-5	2.3E+02	<i>i</i>	2.3E+02	<i>i</i>	2.3E+02	3.0E-03	<i>i</i>	3.0E-03	<i>r</i> 3.0E-03 0.1 <i>RE</i> 1.0
Benzo(a)anthracene	56-55-3	7.3E-01	<i>n</i>	3.9E-01	<i>c</i>	7.3E-01	NA	NA	NA	0.13 <i>RE</i> 1.0
Benzo(a)pyrene	50-32-8	7.3E+00	<i>i</i>	3.9E+00	<i>c</i>	7.3E+00	NA	NA	NA	0.13 <i>RE</i> 1.0
Benzo(b)fluoranthene	205-99-2	7.3E-01	<i>n</i>	3.9E-01	<i>c</i>	7.3E-01	NA	NA	NA	0.13 <i>RE</i> 1.0
Benzo(g,h,i)perylene	191-24-2	NA	NA	NA	3.0E-02	<i>t</i>	3.0E-02	<i>r</i>	3.0E-02	0.13 <i>RE</i> 1.0
Benzo(k)fluoranthene	207-08-9	7.3E-02	<i>n</i>	3.9E-01	<i>c</i>	7.3E-02	NA	NA	NA	0.13 <i>RE</i> 1.0
Benzoic acid	65-85-0	NA	NA	NA	4.0E+00	<i>i</i>	4.0E+00	<i>r</i>	4.0E+00	0.1 <i>RE</i> 1.0
Benzyl alcohol	100-51-6	NA	NA	NA	3.0E-01	<i>h</i>	3.0E-01	<i>r</i>	3.0E-01	0.1 <i>RE</i> 1.0
1,1-Biphenyl	92-52-4	NA	NA	NA	5.0E-02	<i>i</i>	5.0E-02	<i>r</i>	5.0E-02	N/A <i>RE</i> 1.0
Bis(2-chloroethyl)ether	111-44-4	1.1E+00	<i>i</i>	1.2E+00	<i>i</i>	1.1E+00	NA	NA	NA	N/A <i>RE</i> 1.0
Bis(2-chloroisopropyl)ether	108-60-1	7.0E-02	<i>t</i>	3.5E-02	<i>t</i>	7.0E-02	4.0E-02	<i>i</i>	4.0E-02	<i>r</i> 4.0E-02 N/A <i>RE</i> 1.0
Bis(chloromethyl)ether	542-88-1	2.2E+02	<i>i</i>	2.2E+02	<i>i</i>	2.2E+02	NA	NA	NA	N/A <i>RE</i> 1.0
Bis(2-ethylhexyl)phthalate	117-81-7	1.4E-02	<i>i</i>	1.4E-02	<i>r</i>	1.4E-02	2.0E-02	<i>i</i>	2.0E-02	<i>r</i> 2.0E-02 0.1 <i>RE</i> 1.0
Bromochloromethane	74-97-5	NA	NA	NA	4.0E-02	<i>t</i>	1.429E-02	<i>t</i>	4.0E-02	N/A <i>RE</i> 1.0
Bromodichloromethane	75-27-4	6.2E-02	<i>i</i>	1.3E-01	<i>c</i>	6.2E-02	2.0E-02	<i>i</i>	2.0E-02	<i>r</i> 2.0E-02 N/A <i>RE</i> 1.0
Bromoform	75-25-2	7.9E-03	<i>i</i>	3.9E-03	<i>i</i>	7.9E-03	2.0E-02	<i>i</i>	2.0E-02	<i>r</i> 2.0E-02 0.1 <i>RE</i> 1.0
Bromomethane	74-83-9	NA	NA	NA	1.4E-03	<i>i</i>	1.4E-03	<i>i</i>	1.4E-03	N/A <i>RE</i> 1.0
4-Bromophenyl phenyl ether	101-55-3	1.5E+01	<i>t</i>	1.2E+01	<i>t</i>	1.5E+01	NA	NA	NA	0.1 <i>RE</i> 1.0
n-Butylbenzene	104-51-8	NA	NA	NA	4.0E-02	<i>n</i>	4.0E-02	<i>r</i>	4.0E-02	N/A <i>RE</i> 1.0
sec-Butylbenzene	135-98-8	NA	NA	NA	4.0E-02	<i>n</i>	4.0E-02	<i>r</i>	4.0E-02	N/A <i>RE</i> 1.0
tert-Butylbenzene	98-06-6	NA	NA	NA	4.0E-02	<i>n</i>	4.0E-02	<i>r</i>	4.0E-02	N/A <i>RE</i> 1.0
Butyl benzyl phthalate	85-68-7	NA	NA	NA	2.0E-01	<i>i</i>	2.0E-01	<i>r</i>	2.0E-01	0.1 <i>RE</i> 1.0

Table E-1
Toxicity Values of Chemicals

Chemicals	CAS #	Slope Factor				Reference Dose				Absorption Factor				
		Oral, SF _o (mg/kg-day) ⁻¹	Inhalation, SF _i (mg/kg-day) ⁻¹	Dermal, SF _d (mg/kg-day) ⁻¹	Oral, RfD _o (mg/kg-day)	Inhalation, RfD _i (mg/kg-day)	Dermal, RfD _d (mg/kg-day)	Dermal, RAF _d (unitless)	Oral, RAF _o (unitless)					
Carbazole	86-74-8	2.0E-02	<i>h</i>	2.0E-02	<i>r</i>	2.0E-02	NA	NA	NA	0.1	<i>RE</i>	1.0		
Carbon disulfide	75-15-0	NA	NA	NA		1.0E-01	<i>i</i>	2.0E-01	<i>i</i>	1.0E-01	N/A	<i>RE</i>	1.0	
Carbon tetrachloride	56-23-5	1.3E-01	<i>i</i>	5.3E-02	<i>i</i>	1.3E-01	7.0E-04	<i>i</i>	1.1E-02	<i>c</i>	7.0E-04	N/A	<i>RE</i>	1.0
p-Chloroaniline	106-47-8	NA	NA	NA		4.0E-03	<i>i</i>	4.0E-03	<i>r</i>	4.0E-03	0.1	<i>RE</i>	1.0	
Chlorobenzene	108-90-7	NA	NA	NA		2.0E-02	<i>i</i>	1.7E-02	<i>n</i>	2.0E-02	N/A	<i>RE</i>	1.0	
Chloroethane	75-00-3	2.9E-03	<i>n</i>	2.9E-03	<i>r</i>	2.9E-03	4.0E-01	<i>n</i>	2.9E+00	<i>i</i>	4.0E-01	N/A	<i>RE</i>	1.0
Chloroform	67-66-3	3.1E-02	<i>c</i>	8.1E-02	<i>i</i>	3.1E-02	1.0E-02	<i>i</i>	1.4E-02	<i>n</i>	1.0E-02	N/A	<i>RE</i>	1.0
Chloromethane	74-87-3	1.3E-02	<i>t</i>	6.3E-03	<i>t</i>	1.3E-02	2.6E-02	<i>r</i>	2.6E-02	<i>i</i>	2.6E-02	N/A	<i>RE</i>	1.0
2-Chloronaphthalene	91-58-7	NA	NA	NA		8.0E-02	<i>i</i>	8.0E-02	<i>r</i>	8.0E-02	N/A	<i>RE</i>	1.0	
2-Chlorophenol	95-57-8	NA	NA	NA		5.0E-03	<i>i</i>	5.0E-03	<i>r</i>	5.0E-03	N/A	<i>RE</i>	1.0	
4-Chlorophenyl phenyl ether	7005-72-3	1.5E+01	<i>t</i>	1.2E+01	<i>t</i>	1.5E+01	NA	NA	NA	NA	0.1	<i>RE</i>	1.0	
2-Chlorotoluene	95-49-8	NA	NA	NA		2.0E-02	<i>i</i>	2.0E-02	<i>r</i>	2.0E-02	N/A	<i>RE</i>	1.0	
4-Chlorotoluene	106-43-4	NA	NA	NA		2.0E-02	<i>t</i>	7.4E-05	<i>t</i>	2.0E-02	N/A	<i>RE</i>	1.0	
Chrysene	218-01-9	7.3E-03	<i>n</i>	3.9E-02	<i>c</i>	7.3E-03	NA	NA	NA	NA	0.13	<i>RE</i>	1.0	
Dibenzo(a,h)anthracene	53-70-3	7.3E+00	<i>n</i>	4.1E+00	<i>c</i>	7.3E+00	NA	NA	NA	NA	0.13	<i>RE</i>	1.0	
Dibenzofuran	132-64-9	NA	NA	NA		2.0E-03	<i>n</i>	2.0E-03	<i>r</i>	2.0E-03	N/A	<i>RE</i>	1.0	
Dibromochloromethane	124-48-1	8.4E-02	<i>i</i>	9.5E-02	<i>c</i>	8.4E-02	2.0E-02	<i>i</i>	2.0E-02	<i>r</i>	2.0E-02	0.1	<i>RE</i>	1.0
1,2-Dibromo-3-chloropropane	96-12-8	1.4E+00	<i>h</i>	1.4E+00	<i>r</i>	1.4E+00	5.7E-05	<i>r</i>	5.7E-05	<i>i</i>	5.7E-05	0.1	<i>RE</i>	1.0
Dibutyl phthalate	84-74-2	NA	NA	NA		1.0E-01	<i>i</i>	1.0E-01	<i>r</i>	1.0E-01	0.1	<i>RE</i>	1.0	
1,2-Dichlorobenzene	95-50-1	NA	NA	NA		9.0E-02	<i>i</i>	5.7E-02	<i>h</i>	9.0E-02	N/A	<i>RE</i>	1.0	
1,3-Dichlorobenzene	541-73-1	NA	NA	NA		3.0E-02	<i>n</i>	3.0E-02	<i>r</i>	3.0E-02	N/A	<i>RE</i>	1.0	
1,4-Dichlorobenzene	106-46-7	5.4E-03	<i>c</i>	2.2E-02	<i>n</i>	5.4E-03	2.3E-01	<i>n</i>	2.3E-01	<i>i</i>	2.3E-01	N/A	<i>RE</i>	1.0
3,3-Dichlorobenzidine	91-94-1	4.5E-01	<i>i</i>	1.2E+00	<i>c</i>	4.5E-01	NA	NA	NA	NA	0.1	<i>RE</i>	1.0	
Dichlorodifluoromethane	75-71-8	NA	NA	NA		2.0E-01	<i>i</i>	5.7E-02	<i>h</i>	2.0E-01	N/A	<i>RE</i>	1.0	
1,1-Dichloroethane	75-34-3	5.7E-03	<i>c</i>	5.6E-03	<i>c</i>	5.7E-03	1.0E-01	<i>h</i>	1.4E-02	<i>n</i>	1.0E-01	N/A	<i>RE</i>	1.0
1,1-Dichloroethylene	75-35-4	NA	NA	NA		5.0E-02	<i>i</i>	5.7E-02	<i>t</i>	5.0E-02	N/A	<i>RE</i>	1.0	
cis-1,2-Dichloroethylene	156-59-2	NA	NA	NA		1.0E-02	<i>p</i>	1.0E-02	<i>r</i>	1.0E-02	N/A	<i>RE</i>	1.0	
trans-1,2-Dichloroethylene	156-60-5	NA	NA	NA		2.0E-02	<i>i</i>	2.0E-02	<i>r</i>	2.0E-02	N/A	<i>RE</i>	1.0	
2,4-Dichlorophenol	120-83-2	NA	NA	NA		3.0E-03	<i>i</i>	3.0E-03	<i>r</i>	3.0E-03	0.1	<i>RE</i>	1.0	
1,2-Dichloropropane	78-87-5	3.6E-02	<i>c</i>	3.6E-02	<i>c</i>	3.6E-02	1.1E-03	<i>r</i>	1.1E-03	<i>i</i>	1.1E-03	N/A	<i>RE</i>	1.0
1,3-Dichloropropene	542-75-6	1.0E-01	<i>i</i>	1.4E-02	<i>i</i>	1.0E-01	3.0E-02	<i>i</i>	5.7E-03	<i>i</i>	3.0E-02	N/A	<i>RE</i>	1.0
Di(2-ethylhexyl)adipate	103-23-1	1.2E-03	<i>i</i>	1.2E-03	<i>r</i>	1.2E-03	6.0E-01	<i>i</i>	6.0E-01	<i>r</i>	6.0E-01	0.1	<i>RE</i>	1.0
Diethyl phthalate	84-66-2	NA	NA	NA		8.0E-01	<i>i</i>	8.0E-01	<i>r</i>	8.0E-01	0.1	<i>RE</i>	1.0	
Diisopropyl ether (DIPE)	108-20-3	NA	NA	NA		1.0E-01	<i>t</i>	1.1E-01	<i>p</i>	1.0E-01	N/A	<i>RE</i>	1.0	
2,4-Dimethylphenol	105-67-9	NA	NA	NA		2.0E-02	<i>i</i>	2.0E-02	<i>r</i>	2.0E-02	0.1	<i>RE</i>	1.0	
2,6-Dimethylphenol	576-26-1	NA	NA	NA		6.0E-04	<i>i</i>	6.0E-04	<i>r</i>	6.0E-04	0.1	<i>RE</i>	1.0	
Dimethyl phthalate	131-11-3	NA	NA	NA		1.0E+01	<i>h</i>	1.0E+01	<i>r</i>	1.0E+01	0.1	<i>RE</i>	1.0	
1,3-Dinitrobenzene	99-65-0	NA	NA	NA		1.0E-04	<i>i</i>	1.0E-04	<i>r</i>	1.0E-04	0.1	<i>RE</i>	1.0	
2,4-Dinitrophenol	51-28-5	NA	NA	NA		2.0E-03	<i>i</i>	2.0E-03	<i>r</i>	2.0E-03	0.1	<i>RE</i>	1.0	
2,4-Dinitrotoluene	121-14-2	3.1E-01	<i>c</i>	3.1E-01	<i>c</i>	3.1E-01	2.0E-03	<i>i</i>	2.0E-03	<i>r</i>	2.0E-03	0.1	<i>RE</i>	1.0
2,6-Dinitrotoluene	606-20-2	6.8E-01	<i>i</i>	6.8E-01	<i>r</i>	6.8E-01	1.0E-03	<i>h</i>	1.0E-03	<i>r</i>	1.0E-03	0.1	<i>RE</i>	1.0
4-Amino-2,6-dinitrotoluene	19406-51-0	1.0E-02	<i>t</i>	1.0E-02	<i>r</i>	1.0E-02	1.7E-04	<i>t</i>	2.9E-05	<i>t</i>	1.7E-04	0.1	<i>RE</i>	1.0

Table E-1
Toxicity Values of Chemicals

Chemicals	CAS #	Slope Factor			Reference Dose			Absorption Factor						
		Oral, SF _o (mg/kg-day) ⁻¹	Inhalation, SF _i (mg/kg-day) ⁻¹	Dermal, SF _d (mg/kg-day) ⁻¹	Oral, RfD _o (mg/kg-day)	Inhalation, RfD _i (mg/kg-day)	Dermal, RfD _d (mg/kg-day)	Dermal, RAF _d (unitless)	Oral, RAF _o (unitless)					
2-Amino-4,6-dinitrotoluene	35572-78-2	1.0E-02	<i>t</i>	1.0E-02	<i>r</i>	1.0E-02	1.7E-04	<i>t</i>	2.9E-05	<i>t</i>	1.7E-04	0.1	<i>RE</i>	1.0
Di-n-octylphthalate	117-84-0	NA	NA	NA		NA	4.0E-02	<i>p</i>	4.0E-02	<i>r</i>	4.0E-02	0.1	<i>RE</i>	1.0
1,4-Dioxane	123-91-1	1.1E-02	<i>i</i>	2.7E-02	<i>c</i>	1.1E-02	8.6E-01	<i>r</i>	8.6E-01	<i>c</i>	8.6E-01	0.1	<i>RE</i>	1.0
Diphenylamine	122-39-4	NA	NA	NA		NA	2.5E-02	<i>i</i>	2.9E-03	<i>t</i>	2.5E-02	0.1	<i>RE</i>	1.0
1,2-Diphenylhydrazine	122-66-7	8.0E-01	<i>i</i>	7.7E-01	<i>i</i>	8.0E-01	NA		NA		NA	0.1	<i>RE</i>	1.0
Ethanol	64-17-5	NA	NA	NA		NA	3.3E+01	<i>t</i>	5.4E-01	<i>t</i>	3.3E+01	N/A	<i>RE</i>	1.0
Ethylbenzene	100-41-4	NA	NA	NA		NA	1.0E-01	<i>i</i>	2.9E-01	<i>i</i>	1.0E-01	N/A	<i>RE</i>	1.0
Ethylene dibromide (EDB)	106-93-4	2.0E+00	<i>i</i>	2.1E+00	<i>i</i>	2.0E+00	9.0E-03	<i>i</i>	2.6E-03	<i>i</i>	9.0E-03	N/A	<i>RE</i>	1.0
Ethylene dichloride (EDC)	107-06-2	9.1E-02	<i>i</i>	9.1E-02	<i>i</i>	9.1E-02	2.0E-02	<i>n</i>	1.4E-03	<i>n</i>	2.0E-02	N/A	<i>RE</i>	1.0
Ethylene glycol	107-21-1	NA	NA	NA		NA	2.0E+00	<i>i</i>	1.1E-01	<i>c</i>	2.0E+00	0.1	<i>RE</i>	1.0
Ethylene thiourea	96-45-7	4.5E-02	<i>c</i>	4.5E-02	<i>c</i>	4.5E-02	8.0E-05	<i>i</i>	8.0E-05	<i>r</i>	8.0E-05	0.1	<i>RE</i>	1.0
Ethyl-tert-butyl-ether (ETBE)	637-92-3	NA	NA	NA		NA	1.0E-03	<i>t</i>	8.6E-02	<i>t</i>	1.0E-03	N/A	<i>RE</i>	1.0
Fluoranthene	206-44-0	NA	NA	NA		NA	4.0E-02	<i>i</i>	4.0E-02	<i>r</i>	4.0E-02	0.13	<i>RE</i>	1.0
Fluorene	86-73-7	NA	NA	NA		NA	4.0E-02	<i>i</i>	4.0E-02	<i>r</i>	4.0E-02	0.13	<i>RE</i>	1.0
Formaldehyde	50-00-0	4.5E-02	<i>r</i>	4.5E-02	<i>i</i>	4.5E-02	2.0E-01	<i>i</i>	8.6E-04	<i>c</i>	2.0E-01	0.1	<i>RE</i>	1.0
n-Hexane	110-54-3	NA	NA	NA		NA	1.1E+01	<i>p</i>	2.0E-01	<i>i</i>	1.1E+01	N/A	<i>RE</i>	1.0
Hexachlorobenzene	118-74-1	1.6E+00	<i>i</i>	1.6E+00	<i>i</i>	1.6E+00	8.0E-04	<i>i</i>	8.0E-04	<i>r</i>	8.0E-04	0.1	<i>RE</i>	1.0
Hexachlorobutadiene	87-68-3	7.8E-02	<i>i</i>	7.7E-02	<i>i</i>	7.8E-02	3.0E-04	<i>n</i>	3.0E-04	<i>r</i>	3.0E-04	0.1	<i>RE</i>	1.0
Hexachlorocyclopentadiene	77-47-4	NA	NA	NA		NA	6.0E-03	<i>i</i>	5.7E-05	<i>i</i>	6.0E-03	0.1	<i>RE</i>	1.0
Hexachloroethane	67-72-1	1.4E-02	<i>i</i>	1.4E-02	<i>i</i>	1.4E-02	1.0E-03	<i>i</i>	1.0E-03	<i>r</i>	1.0E-03	0.1	<i>RE</i>	1.0
Hexachlorophene	70-30-4	NA	NA	NA		NA	3.0E-04	<i>i</i>	3.0E-04	<i>r</i>	3.0E-04	0.1	<i>RE</i>	1.0
HMX	2691-41-0	NA	NA	NA		NA	5.0E-02	<i>i</i>	7.7E-04	<i>t</i>	5.0E-02	0.1	<i>RE</i>	1.0
Indeno(1,2,3-cd)pyrene	193-39-5	1.2E+00	<i>c</i>	3.9E-01	<i>c</i>	1.2E+00	NA		NA		NA	0.13	<i>RE</i>	1.0
Isophorone	78-59-1	9.5E-04	<i>i</i>	9.5E-04	<i>r</i>	9.5E-04	2.0E-01	<i>i</i>	5.7E-01	<i>c</i>	2.0E-01	0.1	<i>RE</i>	1.0
Isopropylbenzene (Cumene)	98-82-8	NA	NA	NA		NA	1.0E-01	<i>i</i>	1.1E-01	<i>i</i>	1.0E-01	N/A	<i>RE</i>	1.0
4-Isopropyltoluene	99-87-6	NA	NA	NA		NA	3.0E-01	<i>i</i>	3.0E-01	<i>r</i>	3.0E-01	N/A	<i>RE</i>	1.0
Maleic anhydride	108-31-6	NA	NA	NA		NA	1.0E-01	<i>i</i>	2.0E-04	<i>c</i>	1.0E-01	0.1	<i>RE</i>	1.0
Methanol	67-56-1	NA	NA	NA		NA	5.0E-01	<i>i</i>	1.1E+00	<i>c</i>	5.0E-01	N/A	<i>RE</i>	1.0
Methyl butyl ketone	591-78-6	NA	NA	NA		NA	6.0E-02	<i>t</i>	1.1E-03	<i>t</i>	6.0E-02	N/A	<i>RE</i>	1.0
Methyl ethyl ketone	78-93-3	NA	NA	NA		NA	6.0E-01	<i>i</i>	1.4E+00	<i>i</i>	6.0E-01	N/A	<i>RE</i>	1.0
2-Methyl-4,6-dinitrophenol	534-52-1	NA	NA	NA		NA	1.0E-04	<i>p</i>	8.6E-05	<i>t</i>	1.0E-04	0.1	<i>RE</i>	1.0
Methylene chloride	75-09-2	7.5E-03	<i>i</i>	1.6E-03	<i>i</i>	7.5E-03	6.0E-02	<i>i</i>	1.1E-01	<i>c</i>	6.0E-02	N/A	<i>RE</i>	1.0
Methyl iodide	74-88-4	NA	NA	NA		NA	1.4E-03	<i>t</i>	3.4E-03	<i>t</i>	1.4E-03	N/A	<i>RE</i>	1.0
Methyl isobutyl ketone	108-10-1	NA	NA	NA		NA	8.0E-02	<i>h</i>	8.6E-01	<i>i</i>	8.0E-02	N/A	<i>RE</i>	1.0
2-Methylnaphthalene	91-57-6	NA	NA	NA		NA	4.0E-03	<i>i</i>	4.0E-03	<i>r</i>	4.0E-03	N/A	<i>RE</i>	1.0
2-Methylphenol	95-48-7	NA	NA	NA		NA	5.0E-02	<i>i</i>	5.0E-02	<i>r</i>	5.0E-02	0.1	<i>RE</i>	1.0
3-Methylphenol	108-39-4	NA	NA	NA		NA	5.0E-02	<i>i</i>	5.0E-02	<i>r</i>	5.0E-02	0.1	<i>RE</i>	1.0
4-Methylphenol	106-44-5	NA	NA	NA		NA	5.0E-03	<i>h</i>	5.0E-03	<i>r</i>	5.0E-03	0.1	<i>RE</i>	1.0
Methyl tertiary butyl ether (MTBE)	1634-04-4	1.8E-03	<i>c</i>	9.1E-04	<i>n</i>	1.8E-03	8.6E-01	<i>r</i>	8.6E-01	<i>i</i>	8.6E-01	N/A	<i>RE</i>	1.0
Methyl-2,4,6-trinitrophenylnitramine	479-45-8	NA	NA	NA		NA	1.0E-02	<i>t</i>	2.9E-05	<i>t</i>	1.0E-02	0.1	<i>RE</i>	1.0
Naphthalene	91-20-3	1.2E-01	<i>r</i>	1.2E-01	<i>c</i>	1.2E-01	2.0E-02	<i>i</i>	8.6E-04	<i>i</i>	2.0E-02	0.13	<i>RE</i>	1.0
2-Nitroaniline	88-74-4	NA	NA	NA		NA	3.0E-03	<i>p</i>	3.0E-05	<i>p</i>	3.0E-03	0.1	<i>RE</i>	1.0

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Chemicals	CAS #	Slope Factor			Reference Dose			Absorption Factor		
		Oral, SF _o (mg/kg-day) ⁻¹	Inhalation, SF _i (mg/kg-day) ⁻¹	Dermal, SF _d (mg/kg-day) ⁻¹	Oral, RfD _o (mg/kg-day)	Inhalation, RfD _i (mg/kg-day)	Dermal, RfD _d (mg/kg-day)	Dermal, RAF _d (unitless)	Oral, RAF _o (unitless)	
3-Nitroaniline	99-09-2	2.1E-02	p	2.1E-02	r	2.1E-02	3.0E-04	p	3.0E-04	0.1 RE 1.0
4-Nitroaniline	100-01-6	2.1E-02	p	2.1E-02	r	2.1E-02	3.0E-03	p	1.0E-03	3.0E-03 0.1 RE 1.0
Nitrobenzene	98-95-3	NA	NA	NA	NA	5.0E-04	i	5.7E-04	h	5.0E-04 N/A RE 1.0
Nitroglycerin	55-63-0	1.4E-02	n	1.4E-02	r	1.4E-02	7.0E-05	t	7.0E-05	7.0E-05 0.1 RE 1.0
2-Nitrophenol	88-75-5	NA	NA	NA	NA	2.0E-03	t	1.1E-03	t	2.0E-03 0.1 RE 1.0
4-Nitrophenol	100-02-7	NA	NA	NA	NA	2.0E-03	t	2.9E-04	t	2.0E-03 0.1 RE 1.0
n-Nitrosodimethylamine	62-75-9	5.1E+01	i	4.9E+01	i	5.1E+01	8.0E-06	p	8.0E-06	8.0E-06 0.1 RE 1.0
n-Nitrosodi-n-propylamine	621-64-7	7.0E+00	i	7.0E+00	c	7.0E+00	NA	NA	NA	NA 0.1 RE 1.0
n-Nitrosodiphenylamine	86-30-6	4.9E-03	i	9.0E-03	c	4.9E-03	2.0E-02	p	2.0E-02	2.0E-02 0.1 RE 1.0
n-Nitrosopyrrolidine	930-55-2	2.1E+00	i	2.1E+00	i	2.1E+00	NA	NA	NA	NA 0.1 RE 1.0
2-Nitrotoluene	88-72-2	2.3E-01	p	2.3E-01	r	2.3E-01	1.0E-02	t	3.1E-03	1.0E-02 N/A RE 1.0
3-Nitrotoluene	99-08-1	NA	NA	NA	NA	2.0E-02	p	2.0E-02	r	2.0E-02 N/A RE 1.0
4-Nitrotoluene	99-99-0	1.7E-02	p	1.7E-02	r	1.7E-02	1.0E-02	p	1.0E-02	1.0E-02 N/A RE 1.0
Pentachlorobenzene	608-93-5	NA	NA	NA	NA	8.0E-04	i	8.0E-04	r	8.0E-04 0.1 RE 1.0
Pentachloronitrobenzene	82-68-8	2.6E-01	h	2.6E-01	r	2.6E-01	3.0E-03	i	3.0E-03	3.0E-03 0.1 RE 1.0
Pentachlorophenol	87-86-5	1.2E-01	i	1.8E-02	c	1.2E-01	3.0E-02	i	3.0E-02	3.0E-02 0.25 RE 1.0
Pentaerythritol tetranitrate	78-11-5	NA	NA	NA	NA	4.0E-01	t	4.0E-01	r	4.0E-01 0.1 RE 1.0
Phenanthrene	85-01-8	NA	NA	NA	NA	3.0E-02	t	3.0E-02	r	3.0E-02 N/A RE 1.0
Phenol	108-95-2	NA	NA	NA	NA	3.0E-01	i	5.7E-02	c	3.0E-01 0.1 RE 1.0
m-Phenylenediamine	108-45-2	NA	NA	NA	NA	6.0E-03	i	6.0E-03	r	6.0E-03 0.1 RE 1.0
Polychlorinated biphenyls (PCBs)	1336-36-3	2.0E+00	i	3.5E-01	i	2.0E+00	NA	NA	NA	0.14 RE 1.0
n-Propylbenzene	103-65-1	NA	NA	NA	NA	4.0E-02	n	4.0E-02	r	4.0E-02 N/A RE 1.0
Pyrene	129-00-0	NA	NA	NA	NA	3.0E-02	i	3.0E-02	r	3.0E-02 0.13 RE 1.0
RDX	121-82-4	1.1E-01	i	1.1E-01	r	1.1E-01	3.0E-03	i	3.0E-03	3.0E-03 0.1 RE 1.0
Styrene	100-42-5	NA	NA	NA	NA	2.0E-01	i	2.9E-01	i	2.0E-01 N/A RE 1.0
1,1,1,2-Tetrachloroethane	630-20-6	2.6E-02	i	2.6E-02	i	2.6E-02	3.0E-02	i	3.0E-02	3.0E-02 N/A RE 1.0
1,1,2,2-Tetrachloroethane	79-34-5	2.0E-01	i	2.0E-01	i	2.0E-01	6.0E-02	p	6.0E-02	6.0E-02 N/A RE 1.0
1,2,4,5-Tetrachlorobenzene	95-94-3	NA	NA	NA	NA	3.0E-04	i	3.0E-04	r	3.0E-04 0.1 RE 1.0
Tetrachloroethylene	127-18-4	5.4E-01	c	2.1E-02	c	5.4E-01	1.0E-02	i	7.7E-02	1.0E-02 N/A RE 1.0
Tetrahydrofuran	109-99-9	7.6E-03	n	6.8E-03	n	7.6E-03	2.1E-01	n	8.6E-02	2.1E-01 N/A RE 1.0
Tertiary-amyl-methyl-ether (TAME)	994-05-8	NA	NA	NA	NA	4.0E-02	t	2.3E-02	t	4.0E-02 N/A RE 1.0
Tertiary-butyl-alcohol (TBA)	75-65-0	NA	NA	NA	NA	9.0E-02	t	8.6E-02	t	9.0E-02 N/A RE 1.0
Toluene	108-88-3	NA	NA	NA	NA	8.0E-02	i	1.4E+00	i	8.0E-02 N/A RE 1.0
1,2,4-Trichlorobenzene	120-82-1	3.6E-03	c	3.6E-03	r	3.6E-03	1.0E-02	i	1.0E-03	1.0E-02 N/A RE 1.0
1,3,5-Trichlorobenzene	108-70-3	NA	NA	NA	NA	3.0E-03	t	1.1E-02	t	3.0E-03 N/A RE 1.0
1,1,1-Trichloroethane	71-55-6	NA	NA	NA	NA	2.8E-01	n	6.3E-01	p	2.8E-01 N/A RE 1.0
1,1,2-Trichloroethane	79-00-5	5.7E-02	i	5.6E-02	i	5.7E-02	4.0E-03	i	4.0E-03	4.0E-03 N/A RE 1.0
Trichloroethylene	79-01-6	1.3E-02	c	7.0E-03	c	1.3E-02	1.7E-01	r	1.7E-01	1.7E-01 N/A RE 1.0
Trichlorofluoromethane	75-69-4	NA	NA	NA	NA	3.0E-01	i	2.0E-01	h	3.0E-01 N/A RE 1.0
2,4,5-Trichlorophenol	95-95-4	NA	NA	NA	NA	1.0E-01	i	1.0E-01	r	1.0E-01 0.1 RE 1.0
2,4,6-Trichlorophenol	88-06-2	1.1E-02	i	1.1E-02	i	1.1E-02	1.0E-04	n	1.0E-04	1.0E-04 0.1 RE 1.0
1,2,3-Trichloropropane	96-18-4	2.0E+00	n	2.0E+00	r	2.0E+00	6.0E-03	i	1.4E-03	6.0E-03 N/A RE 1.0

Table E-1
Toxicity Values of Chemicals

Chemicals	CAS #	Slope Factor			Reference Dose			Absorption Factor			
		Oral, SF _o (mg/kg-day) ⁻¹	Inhalation, SF _i (mg/kg-day) ⁻¹	Dermal, SF _d (mg/kg-day) ⁻¹	Oral, RfD _o (mg/kg-day)	Inhalation, RfD _i (mg/kg-day)	Dermal, RfD _d (mg/kg-day)	Dermal, RAF _d (unitless)	Oral, RAF _o (unitless)		
1,1,2-Trichlorotrifluoroethane	76-13-1	NA	NA	NA	3.0E+01	<i>i</i>	8.6E+00	<i>h</i>	3.0E+01	N/A <i>RE</i> 1.0	
1,2,4-Trimethylbenzene	95-63-6	NA	NA	NA	5.0E-02	<i>n</i>	1.7E-03	<i>p</i>	5.0E-02	N/A <i>RE</i> 1.0	
1,3,5-Trimethylbenzene	108-67-8	NA	NA	NA	5.0E-02	<i>n</i>	1.7E-03	<i>p</i>	5.0E-02	N/A <i>RE</i> 1.0	
1,3,5-Trinitrobenzene	99-35-4	NA	NA	NA	3.0E-02	<i>i</i>	3.0E-02	<i>r</i>	3.0E-02	0.1 <i>RE</i> 1.0	
2,4,6-Trinitrotoluene (TNT)	118-96-7	3.0E-02	<i>i</i>	3.0E-02	<i>r</i>	3.0E-02	5.0E-04	<i>i</i>	5.0E-04	0.1 <i>RE</i> 1.0	
Vinyl chloride (for residential scenario)	75-01-4	1.4E+00	<i>m</i>	3.1E-02	<i>m</i>	1.4E+00	3.0E-03	<i>i</i>	2.9E-02	N/A <i>RE</i> 1.0	
Vinyl chloride (for occupational scenario)	75-01-4	7.2E-01	<i>m</i>	1.5E-02	<i>m</i>	7.2E-01	3.0E-03	<i>i</i>	2.9E-02	N/A <i>RE</i> 1.0	
Xylenes (total)	1330-20-7	NA	NA	NA	2.0E-01	<i>i</i>	2.9E-02	<i>i</i>	2.0E-01	N/A <i>RE</i> 1.0	
Pesticides											
Acetochlor	34256-82-1	NA	NA	NA	2.0E-02	<i>i</i>	2.0E-02	<i>r</i>	2.0E-02	0.1 <i>RE</i> 1.0	
Acifluorfen	62476-59-9	NA	NA	NA	1.3E-02	<i>i</i>	2.9E-03	<i>t</i>	1.3E-02	0.1 <i>RE</i> 1.0	
Acrolein	107-02-8	NA	NA	NA	5.0E-04	<i>i</i>	5.7E-06	<i>i</i>	5.0E-04	N/A <i>RE</i> 1.0	
Alachlor	15972-60-8	5.6E-02	<i>c</i>	8.0E-02	<i>r</i>	5.6E-02	1.0E-02	<i>i</i>	1.0E-02	0.1 <i>RE</i> 1.0	
Aldicarb	116-06-3	NA	NA	NA	1.0E-03	<i>i</i>	1.0E-03	<i>r</i>	1.0E-03	0.1 <i>RE</i> 1.0	
Aldicarb sulfone	1646-88-4	NA	NA	NA	1.0E-03	<i>i</i>	1.0E-03	<i>r</i>	1.0E-03	0.1 <i>RE</i> 1.0	
Aldrin	309-00-2	1.7E+01	<i>i</i>	1.7E+01	<i>i</i>	1.7E+01	3.0E-05	<i>i</i>	3.0E-05	0.1 <i>RE</i> 1.0	
Ametryn	834-12-8	NA	NA	NA	9.0E-03	<i>i</i>	9.0E-03	<i>r</i>	9.0E-03	0.1 <i>RE</i> 1.0	
Atrazine	1912-24-9	2.3E-01	<i>c</i>	2.2E-01	<i>r</i>	2.3E-01	3.5E-02	<i>i</i>	3.5E-02	0.1 <i>RE</i> 1.0	
Baygon	114-26-1	NA	NA	NA	4.0E-03	<i>i</i>	4.0E-03	<i>r</i>	4.0E-03	0.1 <i>RE</i> 1.0	
Butylate	2008-41-5	NA	NA	NA	5.0E-02	<i>i</i>	5.0E-02	<i>r</i>	5.0E-02	0.1 <i>RE</i> 1.0	
Captan	133-06-2	2.3E-03	<i>c</i>	2.3E-03	<i>c</i>	2.3E-03	1.3E-01	<i>i</i>	1.3E-01	0.1 <i>RE</i> 1.0	
Carbaryl	63-25-2	NA	NA	NA	1.0E-01	<i>i</i>	1.1E-01	<i>r</i>	1.0E-01	0.1 <i>RE</i> 1.0	
Carbofuran	1563-66-2	NA	NA	NA	5.0E-03	<i>i</i>	5.0E-03	<i>r</i>	5.0E-03	0.1 <i>RE</i> 1.0	
Carboxin	5234-68-4	NA	NA	NA	1.0E-01	<i>i</i>	1.0E-01	<i>r</i>	1.0E-01	0.1 <i>RE</i> 1.0	
Chloramben	133-90-4	NA	NA	NA	1.5E-02	<i>i</i>	1.5E-02	<i>r</i>	1.5E-02	0.1 <i>RE</i> 1.0	
Chlordane (technical)	12789-03-6	3.5E-01	<i>i</i>	3.5E-01	<i>i</i>	3.5E-01	5.0E-04	<i>i</i>	2.0E-04	0.1 <i>RE</i> 1.0	
Chlordane, gamma	57-74-9	3.5E-01	<i>t</i>	3.5E-01	<i>t</i>	3.5E-01	5.0E-04	<i>t</i>	2.0E-04	0.04 <i>RE</i> 1.0	
Chlorothalonil	1897-45-6	3.1E-03	<i>c</i>	3.1E-03	<i>c</i>	3.1E-03	1.5E-02	<i>i</i>	1.5E-02	0.04 <i>RE</i> 1.0	
Chlorpyrifos	2921-88-2	NA	NA	NA	3.0E-03	<i>i</i>	3.0E-03	<i>r</i>	3.0E-03	0.1 <i>RE</i> 1.0	
Coumaphos	56-72-4	NA	NA	NA	7.0E-03	<i>t</i>	7.0E-03	<i>r</i>	7.0E-03	0.1 <i>RE</i> 1.0	
Cyanazine	21725-46-2	8.4E-01	<i>h</i>	8.4E-01	<i>r</i>	8.4E-01	2.0E-03	<i>h</i>	2.0E-03	0.1 <i>RE</i> 1.0	
Dacthal	1861-32-1	NA	NA	NA	1.0E-02	<i>i</i>	1.0E-02	<i>r</i>	1.0E-02	0.1 <i>RE</i> 1.0	
Dalapon, sodium salt	75-99-0	NA	NA	NA	3.0E-02	<i>i</i>	3.0E-02	<i>r</i>	3.0E-02	0.1 <i>RE</i> 1.0	
DDD	72-54-8	2.4E-01	<i>i</i>	2.4E-01	<i>c</i>	2.4E-01	NA	NA	NA	0.1 <i>RE</i> 1.0	
DDE	72-55-9	3.4E-01	<i>i</i>	3.4E-01	<i>c</i>	3.4E-01	NA	NA	NA	0.1 <i>RE</i> 1.0	
DDT	50-29-3	3.4E-01	<i>i</i>	3.4E-01	<i>i</i>	3.4E-01	5.0E-04	<i>i</i>	5.0E-04	0.1 <i>RE</i> 1.0	
DEF	78-48-8	NA	NA	NA	NA	3.0E-05	<i>i</i>	3.0E-05	<i>r</i>	3.0E-05	0.03 <i>RE</i> 1.0
Demeton	8065-48-3	NA	NA	NA	4.0E-04	<i>i</i>	4.0E-05	<i>r</i>	4.0E-04	0.1 <i>RE</i> 1.0	
Diazinon	333-41-5	NA	NA	NA	9.0E-04	<i>h</i>	9.0E-04	<i>r</i>	9.0E-04	0.1 <i>RE</i> 1.0	
Dicamba	1918-00-9	NA	NA	NA	3.0E-02	<i>i</i>	3.0E-02	<i>r</i>	3.0E-02	0.1 <i>RE</i> 1.0	
2,4-Dichlorophenoxy acetic acid (2,4-D)	94-75-7	NA	NA	NA	1.0E-02	<i>i</i>	1.0E-02	<i>r</i>	1.0E-02	0.1 <i>RE</i> 1.0	
4-(2,4-Dichlorophenoxy) butyric acid (2,4-DB)	94-82-6	NA	NA	NA	8.0E-03	<i>i</i>	8.0E-03	<i>r</i>	8.0E-03	0.04 <i>RE</i> 1.0	

Table E-1
Toxicity Values of Chemicals

Chemicals	CAS #	Slope Factor			Reference Dose			Absorption Factor		
		Oral, SF _o (mg/kg-day) ⁻¹	Inhalation, SF _i (mg/kg-day) ⁻¹	Dermal, SF _d (mg/kg-day) ⁻¹	Oral, RfD _o (mg/kg-day)	Inhalation, RfD _i (mg/kg-day)	Dermal, RfD _d (mg/kg-day)	Dermal, RAF _d (unitless)	Oral, RAF _o (unitless)	
Dichloroprop (2,4-DP)	120-36-5	NA	NA	NA	1.0E-02	<i>t</i>	1.0E-02	<i>r</i>	1.0E-02	0.05 <i>RE</i> 1.0
Dieldrin	60-57-1	1.6E+01	<i>i</i>	1.6E+01	<i>i</i>	1.6E+01	5.0E-05	<i>i</i>	5.0E-05	5.0E-05 0.1 <i>RE</i> 1.0
Dimethoate	60-51-5	NA	NA	NA	2.0E-04	<i>i</i>	2.0E-04	<i>r</i>	2.0E-04	0.1 <i>RE</i> 1.0
2,4-Dinitro-6-sec-butylphenol (Dinoseb)	88-85-7	NA	NA	NA	1.0E-03	<i>i</i>	1.0E-03	<i>r</i>	1.0E-03	0.1 <i>RE</i> 1.0
Diquat	85-00-7	NA	NA	NA	2.2E-03	<i>i</i>	2.2E-03	<i>r</i>	2.2E-03	0.1 <i>RE</i> 1.0
Disulfoton	298-04-4	NA	NA	NA	4.0E-05	<i>i</i>	4.0E-05	<i>r</i>	4.0E-05	0.1 <i>RE</i> 1.0
Diuron	330-54-1	NA	NA	NA	2.0E-03	<i>i</i>	2.0E-03	<i>r</i>	2.0E-03	0.1 <i>RE</i> 1.0
Endosulfan	115-29-7	NA	NA	NA	6.0E-03	<i>i</i>	6.0E-03	<i>r</i>	6.0E-03	0.1 <i>RE</i> 1.0
Endothall	145-73-3	NA	NA	NA	2.0E-02	<i>i</i>	2.0E-02	<i>r</i>	2.0E-02	0.1 <i>RE</i> 1.0
Endrin	72-20-8	NA	NA	NA	3.0E-04	<i>i</i>	3.0E-04	<i>r</i>	3.0E-04	0.1 <i>RE</i> 1.0
Endrin aldehyde	7421-93-4	NA	NA	NA	3.0E-04	<i>t</i>	3.0E-04	<i>r</i>	3.0E-04	0.1 <i>RE</i> 1.0
Endrin Ketone	53494-70-5	NA	NA	NA	3.0E-04	<i>t</i>	2.9E-05	<i>t</i>	3.0E-04	0.1 <i>RE</i> 1.0
Eptam	759-94-4	NA	NA	NA	2.5E-02	<i>i</i>	2.5E-02	<i>r</i>	2.5E-02	N/A <i>RE</i> 1.0
Ethoprop	13194-48-4	2.8E-02	<i>t</i>	2.8E-02	<i>r</i>	2.8E-02	1.0E-04	<i>t</i>	1.0E-04	0.1 <i>RE</i> 1.0
Fenamiphos	22224-92-6	NA	NA	NA	2.5E-04	<i>i</i>	2.5E-04	<i>r</i>	2.5E-04	0.1 <i>RE</i> 1.0
Fenthion	55-38-9	NA	NA	NA	7.0E-05	<i>t</i>	7.0E-05	<i>r</i>	7.0E-05	0.1 <i>RE</i> 1.0
Fluometuron	2164-17-2	NA	NA	NA	1.3E-02	<i>i</i>	1.3E-02	<i>r</i>	1.3E-02	0.1 <i>RE</i> 1.0
Fonofos	944-22-9	NA	NA	NA	2.0E-03	<i>i</i>	2.0E-03	<i>r</i>	2.0E-03	0.1 <i>RE</i> 1.0
alpha-Hexachlorocyclohexane	319-84-6	6.3E+00	<i>i</i>	6.3E+00	<i>i</i>	6.3E+00	5.0E-04	<i>n</i>	5.0E-04	5.0E-04 0.1 <i>RE</i> 1.0
beta-Hexachlorocyclohexane	319-85-7	1.8E+00	<i>i</i>	1.8E+00	<i>i</i>	1.8E+00	2.0E-04	<i>n</i>	2.0E-04	2.0E-04 0.1 <i>RE</i> 1.0
delta-Hexachlorocyclohexane	319-86-8	1.8E+00	<i>t</i>	1.8E+00	<i>t</i>	1.8E+00	3.0E-04	<i>t</i>	3.0E-04	3.0E-04 0.1 <i>RE</i> 1.0
gamma-Hexachlorocyclohexane	58-89-9	1.1E+00	<i>c</i>	1.1E+00	<i>c</i>	1.1E+00	3.0E-04	<i>i</i>	3.0E-04	3.0E-04 0.1 <i>RE</i> 1.0
Glyphosate	1071-83-6	NA	NA	NA	1.0E-01	<i>i</i>	1.0E-01	<i>r</i>	1.0E-01	0.1 <i>RE</i> 1.0
Guthion	86-50-0	NA	NA	NA	1.5E-03	<i>t</i>	1.5E-03	<i>r</i>	1.5E-03	0.1 <i>RE</i> 1.0
Heptachlor	76-44-8	4.5E+00	<i>i</i>	4.5E+00	<i>i</i>	4.5E+00	5.0E-04	<i>i</i>	5.0E-04	5.0E-04 0.1 <i>RE</i> 1.0
Heptachlor epoxide	1024-57-3	9.1E+00	<i>i</i>	9.1E+00	<i>i</i>	9.1E+00	1.3E-05	<i>i</i>	1.3E-05	1.3E-05 0.1 <i>RE</i> 1.0
Hexazinone	51235-04-2	NA	NA	NA	NA	3.3E-02	<i>i</i>	3.3E-02	<i>r</i>	3.3E-02 0.1 <i>RE</i> 1.0
Malathion	121-75-5	NA	NA	NA	NA	2.0E-02	<i>i</i>	2.0E-02	<i>r</i>	2.0E-02 0.1 <i>RE</i> 1.0
Maleic hydrazide	123-33-1	NA	NA	NA	NA	5.0E-01	<i>i</i>	5.0E-01	<i>r</i>	5.0E-01 0.1 <i>RE</i> 1.0
Maneb	12427-38-2	NA	NA	NA	NA	5.0E-03	<i>i</i>	5.0E-03	<i>r</i>	5.0E-03 0.1 <i>RE</i> 1.0
Methomyl	16752-77-5	NA	NA	NA	NA	2.5E-02	<i>i</i>	2.5E-02	<i>r</i>	2.5E-02 0.1 <i>RE</i> 1.0
Methoxychlor	72-43-5	NA	NA	NA	NA	5.0E-03	<i>i</i>	5.0E-03	<i>r</i>	5.0E-03 0.1 <i>RE</i> 1.0
2-Methyl-4-chlorophenoxyacetic acid (MCPA)	94-74-6	NA	NA	NA	NA	5.0E-04	<i>i</i>	5.0E-04	<i>r</i>	5.0E-04 0.1 <i>RE</i> 1.0
MCPP	93-65-2	NA	NA	NA	NA	1.0E-03	<i>i</i>	1.0E-03	<i>r</i>	1.0E-03 0.1 <i>RE</i> 1.0
Metolachlor	51218-45-2	NA	NA	NA	NA	1.5E-01	<i>i</i>	1.5E-01	<i>r</i>	1.5E-01 0.1 <i>RE</i> 1.0
Metribuzin	21087-64-9	NA	NA	NA	NA	2.5E-02	<i>i</i>	2.5E-02	<i>r</i>	2.5E-02 0.1 <i>RE</i> 1.0
Mirex	2385-85-5	1.8E+01	<i>c</i>	1.8E+01	<i>c</i>	1.8E+01	2.0E-04	<i>i</i>	2.0E-04	2.0E-04 0.1 <i>RE</i> 1.0
Naled	300-76-5	NA	NA	NA	NA	2.0E-03	<i>i</i>	2.0E-03	<i>r</i>	2.0E-03 0.1 <i>RE</i> 1.0
o,o,o-Triethylphosphorothioate	126-68-1	NA	NA	NA	NA	8.3E-06	<i>t</i>	8.3E-06	<i>r</i>	8.3E-06 N/A <i>RE</i> 1.0
Oxamyl	23135-22-0	NA	NA	NA	NA	2.5E-02	<i>i</i>	2.5E-02	<i>r</i>	2.5E-02 0.1 <i>RE</i> 1.0
Paraquat	4685-14-7	NA	NA	NA	NA	4.5E-03	<i>i</i>	4.5E-03	<i>r</i>	4.5E-03 0.1 <i>RE</i> 1.0
ethyl-Parathion	56-38-2	NA	NA	NA	NA	6.0E-03	<i>h</i>	6.0E-03	<i>r</i>	6.0E-03 0.1 <i>RE</i> 1.0

Table E-1
Toxicity Values of Chemicals

Chemicals	CAS #	Slope Factor			Reference Dose			Absorption Factor		
		Oral, SF _o (mg/kg-day) ⁻¹	Inhalation, SF _i (mg/kg-day) ⁻¹	Dermal, SF _d (mg/kg-day) ⁻¹	Oral, RfD _o (mg/kg-day)	Inhalation, RfD _i (mg/kg-day)	Dermal, RfD _d (mg/kg-day)	Dermal, RAF _d (unitless)	Oral, RAF _o (unitless)	
methyl-Parathion	298-00-0	NA	NA	NA	2.5E-04	<i>i</i>	2.5E-04	<i>r</i>	2.5E-04	0.1 <i>RE</i> 1.0
Pendimethalin	40487-42-1	NA	NA	NA	4.0E-02	<i>i</i>	4.0E-02	<i>r</i>	4.0E-02	0.1 <i>RE</i> 1.0
Phenylmercuric acetate	62-38-4	NA	NA	NA	8.0E-05	<i>i</i>	8.0E-05	<i>r</i>	8.0E-05	0.1 <i>RE</i> 1.0
Phorate	298-02-2	NA	NA	NA	2.0E-04	<i>h</i>	2.0E-04	<i>r</i>	2.0E-04	0.1 <i>RE</i> 1.0
Picloram	1918-02-1	NA	NA	NA	7.0E-02	<i>i</i>	7.0E-02	<i>r</i>	7.0E-02	0.1 <i>RE</i> 1.0
Prometon	1610-18-0	NA	NA	NA	1.5E-02	<i>i</i>	1.5E-02	<i>r</i>	1.5E-02	0.1 <i>RE</i> 1.0
Pronamide	23950-58-5	NA	NA	NA	7.5E-02	<i>i</i>	7.5E-02	<i>r</i>	7.5E-02	0.1 <i>RE</i> 1.0
Propachlor	1918-16-7	NA	NA	NA	1.3E-02	<i>i</i>	1.3E-02	<i>r</i>	1.3E-02	0.1 <i>RE</i> 1.0
Propanil	709-98-8	NA	NA	NA	5.0E-03	<i>i</i>	5.0E-03	<i>r</i>	5.0E-03	0.1 <i>RE</i> 1.0
Propazine	139-40-2	4.5E-02	<i>t</i>	4.5E-02	<i>r</i>	4.5E-02	2.0E-02	<i>i</i>	2.0E-02	0.1 <i>RE</i> 1.0
Propham	122-42-9	NA	NA	NA	2.0E-02	<i>i</i>	2.0E-02	<i>r</i>	2.0E-02	0.1 <i>RE</i> 1.0
Silvex (2,4,5-TP)	93-72-1	NA	NA	NA	8.0E-03	<i>i</i>	8.0E-03	<i>r</i>	8.0E-03	0.1 <i>RE</i> 1.0
Simazine	122-34-9	1.2E-01	<i>h</i>	1.2E-01	<i>r</i>	1.2E-01	5.0E-03	<i>i</i>	2.0E-03	5.0E-03 <i>RE</i> 1.0
Strychnine	57-24-9	NA	NA	NA	3.0E-04	<i>i</i>	3.0E-04	<i>r</i>	3.0E-04	0.1 <i>RE</i> 1.0
Tebuthiuron	34014-18-1	NA	NA	NA	7.0E-02	<i>i</i>	7.0E-02	<i>r</i>	7.0E-02	0.1 <i>RE</i> 1.0
Terbacil	5902-51-2	NA	NA	NA	1.3E-02	<i>i</i>	1.3E-02	<i>r</i>	1.3E-02	0.1 <i>RE</i> 1.0
Terbufos	13071-79-9	NA	NA	NA	2.5E-05	<i>h</i>	2.5E-05	<i>r</i>	2.5E-05	0.1 <i>RE</i> 1.0
Terbutryn	886-50-0	NA	NA	NA	1.0E-03	<i>i</i>	1.0E-03	<i>r</i>	1.0E-03	0.1 <i>RE</i> 1.0
Toxaphene	8001-35-2	1.1E+00	<i>i</i>	1.1E+00	<i>i</i>	1.1E+00	NA	NA	NA	0.1 <i>RE</i> 1.0
Triallate	2303-17-5	NA	NA	NA	1.3E-02	<i>i</i>	1.3E-02	<i>r</i>	1.3E-02	0.1 <i>RE</i> 1.0
2,4,5-Trichlorophenoxy acetic acid (2,4,5-T)	93-76-5	NA	NA	NA	1.0E-02	<i>i</i>	1.0E-02	<i>r</i>	1.0E-02	0.1 <i>RE</i> 1.0
Trifluralin	1582-09-8	7.7E-03	<i>i</i>	7.7E-03	<i>r</i>	7.7E-03	7.5E-03	<i>i</i>	7.5E-03	0.1 <i>RE</i> 1.0
Warfarin	81-81-2	NA	NA	NA	3.0E-04	<i>i</i>	2.9E-05	<i>t</i>	3.0E-04	0.1 <i>RE</i> 1.0
Metals										
Aluminum	7429-90-5	NA	NA	NA	1.0E+00	<i>p</i>	1.4E-03	<i>p</i>	1.0E+00	0.01 <i>RE</i> 1.0
Antimony	7440-36-0	NA	NA	NA	4.0E-04	<i>i</i>	1.4E-05	<i>t</i>	4.0E-04	0.01 <i>RE</i> 1.0
Arsenic	7440-38-2	1.5E+00	<i>i</i>	1.5E+01	<i>i</i>	1.5E+00	3.0E-04	<i>i</i>	8.6E-06 <i>c</i>	3.0E-04 <i>RE</i> 1.0
Barium	7440-39-3	NA	NA	NA	2.0E-01	<i>i</i>	1.4E-04	<i>h</i>	2.0E-01	0.01 <i>R3</i> 1.0
Beryllium	7440-41-7	8.4E+00	<i>r</i>	8.4E+00	<i>i</i>	8.4E+00	2.0E-03	<i>i</i>	5.7E-06 <i>i</i>	2.0E-03 <i>RE</i> 1.0
Cadmium	7440-43-9	3.8E-01	<i>c</i>	6.3E+00	<i>i</i>	3.8E-01	1.0E-03	<i>m</i>	NA	1.0E-03 <i>RE</i> 1.0
Chromium (III) total chromium	7440-47-3	NA	NA	NA	1.5E+00	<i>i</i>	2.9E-05	<i>t</i>	1.5E+00	0.01 <i>R3</i> 1.0
Chromium (VI)	18540-29-9	4.2E+01	<i>r</i>	4.2E+01	<i>i</i>	4.2E+01	3.0E-03	<i>i</i>	2.3E-06 <i>i</i>	3.0E-03 <i>R3</i> 1.0
Copper	7440-50-8	NA	NA	NA	4.0E-02	<i>h</i>	2.9E-04	<i>t</i>	4.0E-02	0.01 <i>RE</i> 1.0
Lead	7439-92-1	NA	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	7439-96-5	NA	NA	NA	1.4E-01	<i>i</i>	1.4E-05	<i>i</i>	1.4E-01	0.01 <i>RE</i> 1.0
Mercury	7439-97-6	NA	NA	NA	NA	NA	8.6E-05	<i>i</i>	NA	0.01 <i>RE</i> 1.0
Molybdenum	7439-98-7	NA	NA	NA	5.0E-03	<i>i</i>	1.4E-03	<i>t</i>	5.0E-03	0.01 <i>RE</i> 1.0
Nickel	7440-02-0	NA	9.1E-01	<i>c</i>	NA	2.0E-02	<i>i</i>	2.6E-05 <i>t</i>	2.0E-02	0.01 <i>RE</i> 1.0
Selenium	7782-49-2	NA	NA	NA	5.0E-03	<i>i</i>	5.7E-05 <i>t</i>	5.0E-03	0.01 <i>R3</i> 1.0	
Silver	7440-22-4	NA	NA	NA	5.0E-03	<i>i</i>	2.9E-06	<i>t</i>	5.0E-03	0.01 <i>RE</i> 1.0
Strontium	7440-24-6	NA	NA	NA	6.0E-01	<i>i</i>	NA	NA	6.0E-01	0.01 <i>RE</i> 1.0
Thallium chloride	7791-12-0	NA	NA	NA	8.0E-05	<i>i</i>	2.9E-05 <i>t</i>	8.0E-05	0.01 <i>RE</i> 1.0	

Table E-1
Toxicity Values of Chemicals

Chemicals	CAS #	Slope Factor			Reference Dose			Absorption Factor	
		Oral, SF _o (mg/kg-day) ⁻¹	Inhalation, SF _i (mg/kg-day) ⁻¹	Dermal, SF _d (mg/kg-day) ⁻¹	Oral, RfD _o (mg/kg-day)	Inhalation, RfD _i (mg/kg-day)	Dermal, RfD _d (mg/kg-day)	Dermal, RAF _d (unitless)	Oral, RAF _o (unitless)
Vanadium	7440-62-2	NA	NA	NA	7.0E-03 h	1.4E-05 t	7.0E-03	0.01 RE	1.0
Zinc	7440-66-6	NA	NA	NA	3.0E-01 i	NA	3.0E-01	0.01 RE	1.0
Inorganics									
Ammonia	7664-41-7	NA	NA	NA	NA	2.9E-02 i	NA	0.1 RE	1.0
Cyanide	57-12-5	NA	NA	NA	2.0E-02 i	1.4E-03 t	2.0E-02	0.1 RE	1.0
Cyanide (as Sodium Cyanide)	143-33-9	NA	NA	NA	4.0E-02 i	NA	4.0E-02	0.1 RE	1.0
Cyanogen bromide	506-68-3	NA	NA	NA	9.0E-02 i	9.0E-02 r	9.0E-02	0.1 RE	1.0
Fluoride (as Sodium Fluoride)	7681-49-4	NA	NA	NA	NA	NA	NA	0.1 RE	1.0
Perchlorate	14797-73-0	NA	NA	NA	7.0E-04 i	NA	7.0E-04	0.1 RE	1.0
White phosphorus	7723-14-0	NA	NA	NA	2.0E-05 i	2.9E-05 t	2.0E-05	0.1 RE	1.0
Total Petroleum Hydrocarbons									
TPH-GR0		NA	NA	NA	5.0E+00 th	5.3E+00 th	5.0E+00	N/A	t
Aliphatics - >C6-C8		NA	NA	NA	1.0E-01 th	2.9E-01 th	1.0E-01	N/A	t
Aliphatics - >C8-C10		NA	NA	NA	4.0E-02 th	5.7E-02 th	4.0E-02	N/A	t
Aromatics - >C8-C10		NA	NA	NA	1.0E-01 th	2.9E-01 th	1.0E-01	0.1	t
TPH-DR0		NA	NA	NA	1.0E-01 th	2.9E-01 th	1.0E-01	0.1	t
Aliphatics - >C10-C12		NA	NA	NA	1.0E-01 th	2.9E-01 th	1.0E-01	0.1	t
Aliphatics - >C12-C16		NA	NA	NA	1.0E-01 th	2.9E-01 th	1.0E-01	0.1	t
Aliphatics - >C16-C21		NA	NA	NA	2.0E+00 th	NA	2.0E+00	0.1	t
Aromatics - >C10-C12		NA	NA	NA	4.0E-02 th	5.7E-02 th	4.0E-02	0.1	t
Aromatics - >C12-C16		NA	NA	NA	4.0E-02 th	5.7E-02 th	4.0E-02	0.1	t
Aromatics - >C16-C21		NA	NA	NA	3.0E-02 th	NA	3.0E-02	0.13	t
TPH-ORO		NA	NA	NA	NA	NA	NA	NA	NA
Aliphatics - >C21-C35		NA	NA	NA	2.0E+00 th	NA	2.0E+00	0.1	t
Aromatics - >C21-C35		NA	NA	NA	3.0E-02 th	NA	3.0E-02	0.13	t

The letters in the table represent following sources:

i - USEPA IRIS

p - USEPA PPRTV's

n - USEPA NCEA

c - CALEPA OEHHA

h - HEAST

t - TCEQ's TRRP Tier 1 PCL Table

m - MDNR/DHSS Memo, August 12, 2004

r - Missing value; value showing is identical to a value available for another route of exposure

a - Values assigned based on the most conservative Aroclor values found in the tiered hierarchy

e - Estimated by RAGS Part E

th - TPH and carbon fraction properties taken from TPHCWG handbooks

N/A - Not applicable since chemical is volatile

RE - RAGS Part E

R3 - USEPA Region III (1995)

Chemicals in MRBCA Process for Petroleum Storage Tanks

Lead is evaluated separately using IEUBK model.

Table E-2
Parameters for Dermal Contact Pathway

Chemicals	CAS #	Permeability Constant, K_p (cm/hr)	Relative Contribution of Permeability Coefficient, B (unitless)	Lag Time, τ_{event} (hr/event)	Duration of Event, t^* (hr)	Fraction Absorbed Water, FA (unitless)
VOCs and SVOCs						
Acenaphthene	83-32-9	1.02E-01	e	4.89E-01	e	7.68E-01
Acenaphthylene	208-96-8	8.84E-02	e	4.19E-01	e	7.47E-01
Acetone	67-64-1	5.23E-04	e	1.53E-03	e	2.22E-01
Acetonitrile	75-05-8	5.57E-04	e	1.37E-03	e	1.79E-01
Acrylamide	79-06-1	2.20E-04	RE	7.28E-04	RE	2.66E-01
Acrylic acid	79-10-7	1.23E-03	e	4.00E-03	e	2.66E-01
Acrylonitrile	107-13-1	1.20E-03	RE	3.24E-03	RE	2.11E-01
Allyl alcohol	107-18-6	9.70E-04	e	2.84E-03	e	2.22E-01
Allyl chloride	107-05-1	5.40E-03	RE	1.80E-02	RE	2.86E-01
Aniline	62-53-3	1.90E-03	RE	6.92E-03	RE	3.54E-01
Anthracene	120-12-7	1.92E-01	e	9.88E-01	e	1.05E+00
Aroclor 1016	12674-11-2	2.84E-01	e	1.75E+00	e	2.91E+00
Aroclor 1221	11104-28-2	1.51E-01	e	8.21E-01	e	1.40E+00
Aroclor 1242	53469-21-9	2.53E-01	e	1.59E+00	e	3.27E+00
Aroclor 1248	12672-29-6	4.11E-01	e	2.74E+00	e	5.00E+00
Aroclor 1254	11097-69-1	4.56E-01	e	3.17E+00	e	7.13E+00
Aroclor 1260	11096-82-5	3.84E-01	e	2.86E+00	e	1.34E+01
Azobenzene	103-33-3	2.12E-01	e	1.10E+00	e	1.10E+00
Benzene	71-43-2	1.49E-02	RE	5.05E-02	RE	2.92E-01
Benzidine	92-87-5	1.10E-03	RE	5.88E-03	RE	1.15E+00
Benzo(a)anthracene	56-55-3	4.74E-01	RE	2.75E+00	RE	2.03E+00
Benzo(a)pyrene	50-32-8	7.01E-01	RE	4.27E+00	RE	2.69E+00
Benzo(b)fluoranthene	205-99-2	7.02E-01	RE	4.29E+00	RE	2.77E+00
Benzo(g,h,i)perylene	191-24-2	1.19E+00	e	7.59E+00	e	3.71E+00
Benzo(k)fluoranthene	207-08-9	8.69E-01	e	5.31E+00	e	2.72E+00
Benzoic acid	65-85-0	5.70E-03	RE	2.41E-02	RE	5.15E-01
Benzyl alcohol	100-51-6	2.03E-03	e	8.12E-03	e	4.23E-01
1,1-Biphenyl	92-52-4	6.54E-02	e	3.13E-01	e	7.68E-01
Bis(2-chloroethyl) ether	111-44-4	1.80E-03	RE	8.17E-03	RE	6.75E-01
Bis(2-chloroisopropyl)ether	108-60-1	8.81E-03	e	4.43E-02	e	9.54E-01
Bis(chloromethyl)ether	542-88-1	8.62E-04	e	3.56E-03	e	4.63E-01
Bis(2-ethylhexyl)phthalate	117-81-7	2.50E-02	RE	1.90E-01	RE	1.66E+01
Bromochloromethane	74-97-5	2.22E-03	e	9.72E-03	e	5.58E-01
Bromodichloromethane	75-27-4	4.60E-03	RE	2.27E-02	RE	8.83E-01
Bromoform	75-25-2	2.20E-03	RE	1.37E-02	RE	2.79E+00
Bromomethane	74-83-9	2.80E-03	RE	1.06E-02	RE	3.63E-01
4-Bromophenyl phenyl ether	101-55-3	1.86E-01	e	1.13E+00	e	2.61E+00
n-Butylbenzene	104-51-8	2.01E-01	e	8.82E-01	e	5.62E-01
sec-Butylbenzene	135-98-8	1.48E-01	e	6.51E-01	e	5.62E-01
tert-Butylbenzene	98-06-6	1.70E-01	e	7.46E-01	e	5.62E-01
Butyl benzyl phthalate	85-68-7	4.42E-02	e	3.00E-01	e	5.90E+00
						1.42E+01
						e
						0.90

Table E-2
Parameters for Dermal Contact Pathway

Chemicals	CAS #	Permeability Constant, K_p (cm/hr)	Relative Contribution of Permeability Coefficient, B		Lag Time, τ_{event} (hr/event)	Duration of Event, t^* (hr)	Fraction Absorbed Water, FA (unitless)				
			(unitless)	(unitless)							
Carbazole	86-74-8	2.49E-02	e	1.24E-01	e	9.08E-01	e	2.18E+00	e	0.99	e
Carbon disulfide	75-15-0	1.70E-02	RE	5.91E-02	RE	2.99E-01	RE	7.18E-01	RE	1.00	RE
Carbon tetrachloride	56-23-5	1.60E-02	RE	7.78E-02	RE	7.76E-01	RE	1.86E+00	RE	1.00	RE
p-Chloroaniline	106-47-8	4.18E-03	e	1.81E-02	e	5.45E-01	e	1.31E+00	e	1.00	e
Chlorobenzene	108-90-7	2.80E-02	RE	1.15E-01	RE	4.56E-01	RE	1.09E+00	RE	1.00	RE
Chloroethane	75-00-3	6.10E-03	RE	1.88E-02	RE	2.45E-01	RE	5.88E-01	RE	1.00	RE
Chloroform	67-66-3	6.80E-03	RE	2.87E-02	RE	4.98E-01	RE	1.19E+00	RE	1.00	RE
Chloromethane	74-87-3	3.30E-03	RE	8.97E-03	RE	2.04E-01	RE	4.90E-01	RE	1.00	RE
2-Chloronaphthalene	91-58-7	6.62E-02	e	3.22E-01	e	8.28E-01	e	1.99E+00	e	0.99	e
2-Chlorophenol	95-57-8	8.00E-03	RE	3.48E-02	RE	5.60E-01	RE	1.34E+00	RE	1.00	RE
4-Chlorophenyl phenyl ether	7005-72-3	2.40E-01	e	1.32E+00	e	1.47E+00	e	5.79E+00	e	0.95	e
2-Chlorotoluene	95-49-8	3.99E-02	e	1.73E-01	e	5.41E-01	e	1.30E+00	e	1.00	e
4-Chlorotoluene	106-43-4	4.70E-02	e	2.04E-01	e	5.38E-01	e	1.29E+00	e	1.00	e
Chrysene	218-01-9	4.74E-01	RE	2.75E+00	RE	2.03E+00	RE	8.53E+00	RE	1.00	RE
Dibenzo(a,h)anthracene	53-70-3	1.5E+00	RE	9.68E+00	RE	3.88E+00	RE	1.76E+01	RE	0.60	RE
Dibenzofuran	132-64-9	7.87E-02	e	3.92E-01	e	9.20E-01	e	2.21E+00	e	0.98	e
Dibromochloromethane	124-48-1	3.20E-03	RE	1.79E-02	RE	1.57E+00	RE	3.77E+00	RE	1.00	RE
1,2-Dibromo-3-chloropropane	96-12-8	4.42E-03	e	2.61E-02	e	2.21E+00	e	5.32E+00	e	0.95	e
Dibutyl phthalate	84-74-2	2.40E-02	RE	1.54E-01	RE	3.86E+00	RE	9.27E+00	RE	0.90	RE
1,2-Dichlorobenzene	95-50-1	4.10E-02	RE	1.93E-01	RE	7.11E-01	RE	1.71E+00	RE	1.00	RE
1,3-Dichlorobenzene	541-73-1	5.80E-02	RE	2.70E-01	RE	7.11E-01	RE	1.71E+00	RE	1.00	RE
1,4-Dichlorobenzene	106-46-7	4.20E-02	RE	1.96E-01	RE	7.11E-01	RE	1.71E+00	RE	1.00	RE
3,3-Dichlorobenzidine	91-94-1	1.30E-02	RE	7.83E-02	RE	2.80E+00	RE	6.72E+00	RE	1.00	RE
Dichlorodifluoromethane	75-71-8	9.00E-03	RE	3.79E-02	RE	5.07E-01	RE	1.22E+00	RE	1.00	RE
1,1-Dichloroethane	75-34-3	6.70E-03	RE	2.58E-02	RE	3.82E-01	RE	9.18E-01	RE	1.00	RE
1,1-Dichloroethylene	75-35-4	1.20E-02	RE	4.41E-02	RE	3.72E-01	RE	8.93E-01	RE	1.00	RE
cis-1,2-Dichloroethylene	156-59-2	7.67E-03	e	2.90E-02	e	3.67E-01	e	8.81E-01	e	1.00	e
trans-1,2-Dichloroethylene	156-60-5	1.06E-02	e	4.00E-02	e	3.67E-01	e	8.81E-01	e	1.00	e
2,4-Dichlorophenol	120-83-2	2.10E-02	RE	1.01E-01	RE	8.74E-01	RE	2.10E+00	RE	1.00	RE
1,2-Dichloropropane	78-87-5	7.80E-03	RE	3.17E-02	RE	4.58E-01	RE	1.10E+00	RE	1.00	RE
1,3-Dichloropropene	542-75-6	4.30E-03	RE	1.75E-02	RE	4.47E-01	RE	1.07E+00	RE	1.00	RE
Di(2-ethylhexyl)adipate	103-23-1	3.03E+00	e	2.24E+01	e	1.25E+01	e	5.78E+01	e	0.01	e
Diethyl phthalate	84-66-2	3.90E-03	RE	2.23E-02	RE	1.87E+00	RE	4.50E+00	RE	1.00	RE
Diisopropyl ether (DIPE)	108-20-3	9.04E-03	e	3.51E-02	e	3.92E-01	e	9.40E-01	e	1.00	e
2,4-Dimethylphenol	105-67-9	1.10E-02	RE	4.64E-02	RE	5.16E-01	RE	1.24E+00	RE	1.00	RE
2,6-Dimethylphenol	576-26-1	NA		NA		NA		NA		NA	
Dimethyl phthalate	131-11-3	1.40E-03	RE	7.45E-03	RE	1.30E+00	RE	3.13E+00	RE	1.00	RE
1,3-Dinitrobenzene	99-65-0	2.16E-03	e	1.08E-02	e	9.19E-01	e	2.21E+00	e	0.98	e
2,4-Dinitrophenol	51-28-5	1.50E-03	RE	8.00E-03	RE	1.15E+00	RE	2.76E+00	RE	1.00	RE
2,4-Dinitrotoluene	121-14-2	3.10E-03	RE	1.60E-02	RE	1.12E+00	RE	2.69E+00	RE	1.00	RE
2,6-Dinitrotoluene	606-20-2	2.10E-03	RE	1.07E-02	RE	1.12E+00	RE	2.69E+00	RE	1.00	RE
4-Amino-2,6-dinitrotoluene	19406-51-0	6.69E-03	e	3.61E-02	e	1.34E+00	e	3.21E+00	e	0.97	e

Table E-2
Parameters for Dermal Contact Pathway

Chemicals	CAS #	Permeability Constant, K_p (cm/hr)	Relative Contribution of Permeability Coefficient, B (unitless)		Lag Time, τ_{event} (hr/event)	Duration of Event, t^* (hr)	Fraction Absorbed Water, FA (unitless)				
2-Amino-4,6-dinitrotoluene	35572-78-2	8.79E-03	e	4.75E-02	e	1.34E+00	e	3.21E+00	e	0.97	e
Di-n-octylphthalate	117-84-0	4.60E+00	e	3.50E+01	e	1.62E+01	e	7.54E+01	e	0.01	e
1,4-Dioxane	123-91-1	3.30E-04	RE	1.20E-03	RE	3.32E-01	RE	7.97E-01	RE	1.00	RE
Diphenylamine	122-39-4	2.66E-02	e	1.33E-01	e	9.32E-01	e	2.24E+00	e	0.98	e
1,2-Diphenylhydrazine	122-66-7	1.30E-02	RE	6.80E-02	RE	1.15E+00	RE	2.76E+00	RE	1.00	RE
Ethanol	64-17-5	5.38E-04	RE	1.40E-03	RE	1.93E-01	RE	4.63E-01	RE	1.00	RE
Ethylbenzene	100-41-4	4.93E-02	RE	1.95E-01	RE	4.20E-01	RE	1.01E+00	RE	1.00	RE
Ethylene dibromide (EDB)	106-93-4	2.77E-03	RE	1.46E-02	RE	1.21E+00	RE	2.90E+00	RE	1.00	RE
Ethylene dichloride (EDC)	107-06-2	4.20E-03	RE	1.61E-02	RE	3.82E-01	RE	9.18E-01	RE	1.00	RE
Ethylene glycol	107-21-1	1.15E-04	e	3.48E-04	e	2.34E-01	e	5.62E-01	e	1.00	e
Ethylene thiourea	96-45-7	1.70E-04	RE	6.22E-04	RE	3.68E-01	RE	8.83E-01	RE	1.00	RE
Ethyl-tert-butyl-ether (ETBE)	637-92-3	6.28E-03	e	2.44E-02	e	3.92E-01	e	9.40E-01	e	1.00	e
Fluoranthene	206-44-0	2.24E-01	RE	1.22E+00	RE	1.45E+00	RE	5.68E+00	RE	1.00	RE
Fluorene	86-73-7	1.36E-01	e	6.75E-01	e	8.97E-01	e	3.50E+00	e	1.00	e
Formaldehyde	50-00-0	1.80E-03	RE	3.83E-03	RE	1.57E-01	RE	3.76E-01	RE	1.00	RE
n-Hexane	110-54-3	7.74E-02	e	2.76E-01	e	3.19E-01	e	7.67E-01	e	1.00	e
Hexachlorobenzene	118-74-1	1.30E-01	RE	8.67E-01	RE	4.22E+00	RE	1.62E+01	RE	0.90	RE
Hexachlorobutadiene	87-68-3	8.10E-02	RE	5.03E-01	RE	3.09E+00	RE	7.42E+00	RE	0.90	RE
Hexachlorocyclopentadiene	77-47-4	5.31E-02	e	3.37E-01	e	3.54E+00	e	8.50E+00	e	0.95	e
Hexachloroethane	67-72-1	3.00E-02	RE	1.78E-01	RE	2.27E+00	RE	5.44E+00	RE	1.00	RE
Hexachlorophene	70-30-4	3.09E-01	e	2.40E+00	e	2.00E+01	e	8.28E+01	e	0.50	e
HMX	2691-41-0	4.82E-06	e	3.19E-05	e	4.79E+00	e	1.15E+01	e	0.94	e
Indeno(1,2,3-cd)pyrene	193-39-5	1.00E+00	RE	6.65E+00	RE	3.78E+00	RE	1.68E+01	RE	0.60	RE
Isophorone	78-59-1	3.40E-03	RE	1.53E-02	RE	6.35E-01	RE	1.52E+00	RE	1.00	RE
Isopropylbenzene (Cumene)	98-82-8	6.36E-02	e	2.68E-01	e	4.95E-01	e	1.19E+00	e	1.00	e
4-Isopropyltoluene	99-87-6	1.52E-01	e	6.76E-01	e	5.94E-01	e	2.32E+00	e	1.00	e
Maleic anhydride	108-31-6	5.25E-03	e	2.00E-02	e	3.72E-01	e	8.94E-01	e	1.00	e
Methanol	67-56-1	3.2E-04	RE	6.94E-04	RE	1.61E-01	RE	3.86E-01	RE	1.00	RE
Methyl butyl ketone	591-78-6	4.15E-03	e	1.60E-02	e	3.83E-01	e	9.18E-01	e	1.00	e
Methyl ethyl ketone	78-93-3	9.60E-04	RE	3.14E-03	RE	2.70E-01	RE	6.47E-01	RE	1.00	RE
2-Methyl-4,6-dinitrophenol	534-52-1	3.10E-03	RE	1.68E-02	RE	1.38E+00	RE	3.30E+00	RE	1.00	RE
Methylene chloride	75-09-2	3.50E-03	RE	1.26E-02	RE	3.19E-01	RE	7.65E-01	RE	1.00	RE
Methyl iodide	74-88-4	2.50E-03	RE	1.16E-02	RE	6.66E-01	RE	1.60E+00	RE	1.00	RE
Methyl isobutyl ketone	108-10-1	2.70E-03	RE	1.02E-02	RE	3.87E-01	RE	9.30E-01	RE	1.00	RE
2-Methylnaphthalene	91-57-6	7.20E-02	e	3.30E-01	e	6.56E-01	e	1.57E+00	e	0.98	e
2-Methylphenol	95-48-7	7.70E-03	RE	3.06E-02	RE	4.30E-01	RE	1.03E+00	RE	1.00	RE
3-Methylphenol	108-39-4	7.80E-03	RE	3.11E-02	RE	4.30E-01	RE	1.03E+00	RE	1.00	RE
4-Methylphenol	106-44-5	7.70E-03	RE	3.06E-02	RE	4.30E-01	RE	1.03E+00	RE	1.00	RE
Methyl tertiary butyl ether (MTBE)	1634-04-4	3.40E-03	e	1.23E-02	e	3.28E-01	e	7.87E-01	e	1.00	e
Methyl-2,4,6-trinitrophenylnitramine	479-45-8	8.68E-04	e	5.66E-03	e	4.26E+00	e	1.02E+01	e	0.95	e
Naphthalene	91-20-3	4.66E-02	RE	2.03E-01	RE	5.58E-01	RE	1.34E+00	RE	1.00	RE
2-Nitroaniline	88-74-4	5.76E-03	e	2.60E-02	e	6.23E-01	e	1.50E+00	e	1.00	e

Table E-2
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3-Nitroaniline	99-09-2	3.14E-03	e	1.42E-02	e	6.23E-01	e	1.50E+00	e	1.00	e
4-Nitroaniline	100-01-6	1.36E-03	e	6.14E-03	e	6.23E-01	e	1.50E+00	e	1.00	e
Nitrobenzene	98-95-3	5.07E-03	e	2.16E-02	e	5.14E-01	e	1.23E+00	e	1.00	e
Nitroglycerin	55-63-0	1.77E-03	e	1.03E-02	e	1.97E+00	e	4.72E+00	e	0.97	e
2-Nitrophenol	88-75-5	4.00E-03	RE	1.82E-02	RE	6.42E-01	RE	1.54E+00	RE	1.00	RE
4-Nitrophenol	100-02-7	4.80E-03	RE	2.19E-02	RE	6.42E-01	RE	1.54E+00	RE	1.00	RE
n-Nitrosodimethylamine	62-75-9	2.50E-04	RE	8.32E-04	RE	2.77E-01	RE	6.65E-01	RE	1.00	RE
n-Nitrosodi-n-propylamine	621-64-7	2.30E-03	RE	1.02E-02	RE	5.72E-01	RE	1.37E+00	RE	1.00	RE
n-Nitrosodiphenylamine	86-30-6	1.50E-02	RE	7.88E-02	RE	1.38E+00	RE	3.31E+00	RE	1.00	RE
n-Nitrosopyrrolidine*	930-55-2	6.19E-04	e	2.38E-03	e	3.82E-01	e	9.18E-01	e	1.00	e
2-Nitrotoluene	88-72-2	9.73E-03	e	4.38E-02	e	6.16E-01	e	1.48E+00	e	1.00	e
3-Nitrotoluene	99-08-1	9.73E-03	e	4.38E-02	e	6.16E-01	e	1.48E+00	e	1.00	e
4-Nitrotoluene	99-99-0	9.73E-03	e	4.38E-02	e	6.16E-01	e	1.48E+00	e	1.00	e
Pentachlorobenzene	608-93-5	1.75E-01	e	1.07E+00	e	2.65E+00	e	1.03E+01	e	0.94	e
Pentachloronitrobenzene	82-68-8	4.20E-02	RE	2.76E-01	RE	4.83E+00	RE	1.16E+01	RE	0.90	RE
Pentachlorophenol	87-86-5	3.90E-01	RE	2.47E+00	RE	3.33E+00	RE	1.38E+01	RE	0.90	RE
Pentaerythritol tetranitrate	78-11-5	9.55E-03	e	6.53E-02	e	6.20E+00	e	1.49E+01	e	0.95	e
Phenanthrene	85-01-8	1.40E-01	RE	7.40E-01	RE	1.06E+00	RE	4.11E+00	RE	1.00	RE
Phenol	108-95-2	4.30E-03	RE	1.62E-02	RE	3.59E-01	RE	8.61E-01	RE	1.00	RE
m-Phenylenediamine	108-45-2	2.17E-04	e	8.68E-04	e	4.24E-01	e	1.02E+00	e	1.00	e
Polychlorinated biphenyls (PCBs)	1336-36-3	3.41E-01	e	2.37E+00	e	7.04E+00	e	2.91E+01	e	0.75	e
n-Propylbenzene	103-65-1	9.74E-02	e	4.11E-01	e	4.95E-01	e	1.19E+00	e	1.00	e
Pyrene	129-00-0	3.26E-01	e	1.79E+00	e	1.43E+00	e	5.76E+00	e	0.95	e
RDX	121-82-4	6.42E-04	e	3.25E-03	e	9.73E-01	e	2.34E+00	e	0.98	e
Styrene	100-42-5	3.70E-02	RE	1.46E-01	RE	4.08E-01	RE	9.80E-01	RE	1.00	RE
1,1,1,2-Tetrachloroethane	630-20-6	1.57E-02	e	7.82E-02	e	9.16E-01	e	2.20E+00	e	0.99	e
1,1,2,2-Tetrachloroethane	79-34-5	6.90E-03	RE	3.46E-02	RE	9.31E-01	RE	2.24E+00	RE	1.00	RE
1,2,4,5-Tetrachlorobenzene	95-94-3	1.02E-01	e	5.75E-01	e	1.70E+00	e	4.08E+00	e	0.95	e
Tetrachloroethylene	127-18-4	3.30E-02	RE	1.66E-01	RE	9.06E-01	RE	2.18E+00	RE	1.00	RE
Tetrahydrofuran	109-99-9	1.62E-03	e	5.28E-03	e	2.66E-01	e	6.40E-01	e	1.00	e
Tertiary-amyl-methyl-ether (TAME)	994-05-8	6.77E-03	e	2.63E-02	e	3.92E-01	e	9.40E-01	e	1.00	e
Tertiary-butyl-alcohol (TBA)	75-65-0	2.14E-03	e	7.08E-03	e	2.73E-01	e	6.56E-01	e	1.00	e
Toluene	108-88-3	3.11E-02	RE	1.15E-01	RE	3.50E-01	RE	8.39E-01	RE	1.00	RE
1,2,4-Trichlorobenzene	120-82-1	6.60E-02	RE	3.43E-01	RE	1.11E+00	RE	2.66E+00	RE	1.00	RE
1,3,5-Trichlorobenzene	108-70-3	8.90E-02	e	4.61E-01	e	1.09E+00	e	2.62E+00	e	0.97	e
1,1,1-Trichloroethane	71-55-6	1.30E-02	RE	5.61E-02	RE	5.96E-01	RE	1.43E+00	RE	1.00	RE
1,1,2-Trichloroethane	79-00-5	6.40E-03	RE	2.86E-02	RE	5.96E-01	RE	1.43E+00	RE	1.00	RE
Trichloroethylene	79-01-6	1.20E-02	RE	5.13E-02	RE	5.81E-01	RE	1.39E+00	RE	1.00	RE
Trichlorofluoromethane	75-69-4	1.30E-02	RE	5.75E-02	RE	6.28E-01	RE	1.51E+00	RE	1.00	RE
2,4,5-Trichlorophenol	95-95-4	2.34E-02	e	1.26E-01	e	1.34E+00	e	3.22E+00	e	0.98	e
2,4,6-Trichlorophenol	88-06-2	3.50E-02	RE	1.87E-01	RE	1.36E+00	RE	3.27E+00	RE	1.00	RE
1,2,3-Trichloropropane	96-18-4	1.06E-02	e	4.97E-02	e	7.04E-01	e	1.69E+00	e	1.00	e

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1,1,2-Trichlorotrifluoroethane	76-13-1	1.55E-02	e	8.15E-02	e	1.18E+00	e	2.83E+00	e	0.97	e
1,2,4-Trimethylbenzene	95-63-6	8.63E-02	e	3.64E-01	e	4.95E-01	e	1.19E+00	e	1.00	e
1,3,5-Trimethylbenzene	108-67-8	9.31E-02	e	3.93E-01	e	4.95E-01	e	1.19E+00	e	1.00	e
1,3,5-Trinitrobenzene	99-35-4	9.13E-04	e	5.13E-03	e	1.64E+00	e	3.94E+00	e	0.98	e
2,4,6-Trinitrotoluene (TNT)	118-96-7	1.75E-03	e	1.02E-02	e	1.97E+00	e	4.72E+00	e	0.98	e
Vinyl chloride (for residential scenario)	75-01-4	5.60E-03	RE	1.70E-02	RE	2.39E-01	RE	5.73E-01	RE	1.00	RE
Vinyl chloride (for occupational scenario)	75-01-4	5.60E-03	RE	1.70E-02	RE	2.39E-01	RE	5.73E-01	RE	1.00	RE
Xylenes (total)	1330-20-7	2.89E-02	e	1.14E-01	e	4.13E-01	e	9.92E-01	e	1.00	e
Pesticides											
Acetochlor	34256-82-1	2.11E-03	e	1.33E-02	e	3.41E+00	e	8.18E+00	e	0.97	e
Acifluorfen	62476-59-9	2.63E-05	e	1.93E-04	e	1.12E+01	e	2.68E+01	e	0.90	e
Acrolein	107-02-8	6.50E-04	RE	1.88E-03	RE	2.20E-01	RE	5.27E-01	RE	1.00	RE
Alachlor	15972-60-8	8.22E-03	e	5.19E-02	e	3.40E+00	e	8.15E+00	e	0.92	e
Aldicarb	116-06-3	1.08E-03	e	5.71E-03	e	1.22E+00	e	2.93E+00	e	0.98	e
Aldicarb sulfone	1646-88-4	3.28E-05	e	9.80E-01	e	1.85E+00	e	7.12E+00	e	0.95	e
Aldrin	309-00-2	1.40E-03	RE	1.03E-02	RE	1.19E+01	RE	2.85E+01	RE	1.00	RE
Ametryn	834-12-8	6.78E-03	e	3.93E-02	e	1.97E+00	e	4.73E+00	e	0.97	e
Atrazine	1912-24-9	7.13E-03	e	4.03E-02	e	1.70E+00	e	4.07E+00	e	0.95	e
Baygon	114-26-1	NA		NA		NA		NA		NA	
Butylate	2008-41-5	3.36E-02	e	1.90E-01	e	1.73E+00	e	4.16E+00	e	0.98	e
Captan	133-06-2	1.20E-03	RE	7.88E-03	RE	5.13E+00	RE	1.23E+01	RE	1.00	RE
Carbaryl	63-25-2	4.21E-03	e	2.30E-02	e	1.41E+00	e	3.38E+00	e	0.98	e
Carbofuran	1563-66-2	3.01E-03	e	1.72E-02	e	1.82E+00	e	4.38E+00	e	0.98	e
Carboxin	5234-68-4	7.51E-03	e	4.43E-02	e	2.19E+00	e	5.25E+00	e	0.97	e
Chloramben	133-90-4	4.80E-03	e	2.65E-02	e	1.50E+00	e	3.61E+00	e	0.98	e
Chlordane (technical)	12789-03-6	1.83E-01	e	1.42E+00	e	2.07E+01	e	8.20E+01	e	0.55	e
Chlordane, gamma	57-74-9	3.80E-02	RE	2.94E-01	RE	2.12E+01	RE	5.09E+01	RE	0.70	RE
Chlorothalonil	1897-45-6	1.90E-02	RE	1.16E-01	RE	3.30E+00	RE	7.93E+00	RE	0.90	RE
Chlorpyrifos	2921-88-2	2.05E-02	e	1.48E-01	e	9.66E+00	e	2.32E+01	e	0.90	e
Coumaphos	56-72-4	9.55E-03	e	7.00E-02	e	1.13E+01	e	2.71E+01	e	0.88	e
Cyanazine	21725-46-2	9.71E-04	e	5.79E-03	e	2.34E+00	e	5.62E+00	e	0.97	e
Dacthal	1861-32-1	2.81E-02	e	1.97E-01	e	7.60E+00	e	1.82E+01	e	0.90	e
Dalapon, sodium salt	75-99-0	2.85E-03	e	1.31E-02	e	6.64E-01	e	1.59E+00	e	1.00	e
DDD	72-54-8	1.80E-01	RE	1.23E+00	RE	6.65E+00	RE	2.60E+01	RE	0.80	RE
DDE	72-55-9	1.60E-01	RE	1.07E+00	RE	6.48E+00	RE	2.51E+01	RE	0.80	RE
DDT	50-29-3	2.70E-01	RE	1.95E+00	RE	1.04E+01	RE	4.25E+01	RE	0.70	RE
DEF	78-48-8	1.59E-01	e	1.08E+00	e	6.07E+00	e	2.35E+01	e	0.85	e
Demeton	8065-48-3	5.17E-03	e	3.20E-02	e	2.94E+00	e	7.06E+00	e	0.97	e
Diazinon	333-41-5	1.11E-02	e	7.46E-02	e	5.32E+00	e	1.28E+01	e	0.92	e
Dicamba	1918-00-9	2.37E-03	e	1.35E-02	e	1.82E+00	e	4.36E+00	e	0.98	e
2,4-Dichlorophenoxy acetic acid (2,4-D)	94-75-7	4.89E-03	e	2.80E-02	e	1.82E+00	e	4.36E+00	e	0.98	e
4-(2,4-Dichlorophenoxy) butyric acid (2,4-DB)	94-82-6	2.02E-02	e	1.22E-01	e	2.61E+00	e	6.27E+00	e	0.97	e

Table E-2
Parameters for Dermal Contact Pathway

Chemicals	CAS #	Permeability Constant, K_p (cm/hr)	Relative Contribution of Permeability Coefficient, B (unitless)		Lag Time, τ_{event} (hr/event)	Duration of Event, t^* (hr)	Fraction Absorbed Water, FA (unitless)				
Dichloroprop (2,4-DP)	120-36-5	1.09E-02	e	6.43E-02	e	2.18E+00	e	5.23E+00	e	0.97	e
Dieldrin	60-57-1	1.20E-02	RE	9.18E-02	RE	1.46E+01	RE	3.51E+01	RE	0.80	RE
Dimethoate	60-51-5	1.26E-04	e	7.33E-04	e	2.02E+00	e	4.85E+00	e	0.97	e
2,4-Dinitro-6-sec-butylphenol (Dinoseb)	88-85-7	1.90E-02	e	1.13E-01	e	2.33E+00	e	5.59E+00	e	0.97	e
Diquat	85-00-7	2.58E-07	e	1.84E-06	e	8.88E+00	e	2.13E+01	e	0.92	e
Disulfoton	298-04-4	1.63E-02	e	1.04E-01	e	3.62E+00	e	8.68E+00	e	0.95	e
Diuron	330-54-1	4.56E-03	e	2.68E-02	e	2.12E+00	e	5.10E+00	e	0.97	e
Endosulfan	115-29-7	2.85E-03	e	2.21E-02	e	2.00E+01	e	4.80E+01	e	0.80	e
Endothall	145-73-3	2.54E-03	e	1.33E-02	e	1.16E+00	e	2.78E+00	e	0.99	e
Endrin	72-20-8	1.20E-02	RE	9.18E-02	RE	1.46E+01	RE	3.51E+01	RE	0.80	RE
Endrin aldehyde	7421-93-4	2.07E-01	e	1.56E+00	e	1.43E+01	e	5.70E+01	e	0.68	e
Endrin Ketone	53494-70-5	3.84E-02	e	2.88E-01	e	1.43E+01	e	3.43E+01	e	0.83	e
Eptam	759-94-4	1.35E-02	e	7.16E-02	e	1.21E+00	e	2.90E+00	e	0.99	e
Ethoprop	13194-48-4	8.23E-03	e	4.93E-02	e	2.39E+00	e	5.74E+00	e	0.97	e
Fenamiphos	22224-92-6	NA		NA		NA		NA		NA	
Fenthion	55-38-9	4.58E-03	e	2.94E-02	e	3.81E+00	e	9.13E+00	e	0.95	e
Fluometuron	2164-17-2	NA		NA		NA		NA		NA	
Fonofos	944-22-9	2.89E-02	e	1.74E-01	e	2.52E+00	e	6.05E+00	e	0.97	e
alpha-Hexachlorocyclohexane	319-84-6	2.42E-02	e	1.58E-01	e	4.47E+00	e	1.07E+01	e	0.92	e
beta-Hexachlorocyclohexane	319-85-7	2.42E-02	e	1.58E-01	e	4.47E+00	e	1.07E+01	e	0.95	e
delta-Hexachlorocyclohexane	319-86-8	1.63E-02	e	1.07E-01	e	4.47E+00	e	1.07E+01	e	0.95	e
gamma-Hexachlorocyclohexane	58-89-9	1.10E-02	RE	7.10E-02	RE	4.57E+00	RE	1.10E+01	RE	0.90	RE
Glyphosate	1071-83-6	1.57E-05	e	7.88E-05	e	9.30E-01	e	2.23E+00	e	0.99	e
Guthion	86-50-0	1.18E-03	e	8.10E-03	e	6.29E+00	e	1.51E+01	e	0.93	e
Heptachlor	76-44-8	8.60E-03	RE	6.43E-02	RE	1.33E+01	RE	3.19E+01	RE	0.80	RE
Heptachlor epoxide	1024-57-3	1.81E-02	e	1.37E-01	e	1.59E+01	e	3.82E+01	e	0.86	e
Hexazinone	51235-04-2	1.61E-03	e	9.85E-03	e	2.72E+00	e	6.53E+00	e	0.97	e
Malathion	121-75-5	7.24E-04	e	5.06E-03	e	7.45E+00	e	1.79E+01	e	0.91	e
Maleic hydrazide	123-33-1	9.70E-05	e	3.95E-04	e	4.46E-01	e	1.07E+00	e	1.00	e
Maneb	12427-38-2	NA		NA		NA		NA		NA	
Methylm	16752-77-5	4.95E-04	e	2.42E-03	e	8.52E-01	e	2.04E+00	e	0.99	e
Methoxychlor	72-43-5	1.01E-01	e	7.23E-01	e	9.07E+00	e	3.51E+01	e	0.82	e
2-Methyl-4-chlorophenoxyacetic acid (MCPA)	94-74-6	2.06E-02	e	1.12E-01	e	1.40E+00	e	3.35E+00	e	0.98	e
MCPP	93-65-2	1.16E-02	e	6.55E-02	e	1.67E+00	e	4.02E+00	e	0.97	e
Metolachlor	51218-45-2	3.33E-03	e	2.16E-02	e	4.08E+00	e	9.80E+00	e	0.95	e
Metribuzin	21087-64-9	1.76E-04	e	9.92E-04	e	1.67E+00	e	4.00E+00	e	0.97	e
Mirex	2385-85-5	2.54E+01	e	2.28E+02	e	1.19E+02	e	5.61E+02	e	0.00	e
Naled	300-76-5	1.33E-04	e	9.98E-04	e	1.43E+01	e	3.42E+01	e	0.86	e
o,o,o-Triethylphosphorothioate	126-68-1	6.80E-03	e	3.68E-02	e	1.35E+00	e	3.25E+00	e	0.97	e
Oxamyl	23135-22-0	1.52E-05	e	8.63E-05	e	1.78E+00	e	4.26E+00	e	0.97	e
Paraquat	4685-14-7	6.16E-08	e	3.80E-07	e	2.90E+00	e	6.95E+00	e	0.96	e
ethyl-Parathion	56-38-2	1.30E-02	RE	8.40E-02	RE	4.57E+00	RE	1.10E+01	RE	0.90	RE

Table E-2
Parameters for Dermal Contact Pathway

Chemicals	CAS #	Permeability Constant, K_p (cm/hr)	Relative Contribution of Permeability Coefficient, B		Lag Time, τ_{event} (hr/event)	Duration of Event, t* (hr)	Fraction Absorbed Water, FA (unitless)		
			(unitless)						
methyl-Parathion	298-00-0	3.47E-03	e	2.16E-02	e	3.13E+00	e	0.95	e
Pendimethalin	40487-42-1	1.48E-01	e	9.52E-01	e	3.96E+00	e	1.52E+01	e
Phenylmercuric acetate	62-38-4	7.97E-05	e	5.63E-04	e	8.08E+00	e	1.94E+01	e
Phorate	298-02-2	9.21E-03	e	5.72E-02	e	3.02E+00	e	7.25E+00	e
Picloram	1918-02-1	6.14E-03	e	3.67E-02	e	2.37E+00	e	5.68E+00	e
Prometon	1610-18-0	6.90E-03	e	3.99E-02	e	1.92E+00	e	4.61E+00	e
Pronamide	23950-58-5	1.33E-02	e	8.21E-02	e	2.86E+00	e	6.86E+00	e
Propachlor	1918-16-7	NA	NA	NA	NA	NA	NA	NA	NA
Propanil	709-98-8	8.75E-03	e	4.97E-02	e	1.75E+00	e	4.20E+00	e
Propazine	139-40-2	1.14E-02	e	6.67E-02	e	2.03E+00	e	4.88E+00	e
Propham	122-42-9	8.95E-03	e	4.61E-02	e	1.06E+00	e	2.55E+00	e
Silvex (2,4,5-TP)	93-72-1	1.32E-02	e	8.31E-02	e	3.40E+00	e	8.15E+00	e
Simazine	122-34-9	6.50E-03	e	3.55E-02	e	1.42E+00	e	3.40E+00	e
Strychnine	57-24-9	3.52E-04	e	2.48E-03	e	7.85E+00	e	1.88E+01	e
Tebuthiuron	34014-18-1	1.27E-03	e	7.36E-03	e	2.00E+00	e	4.79E+00	e
Terbacil	5902-51-2	NA	NA	NA	NA	NA	NA	NA	NA
Terbufos	13071-79-9	2.26E-02	e	1.48E-01	e	4.34E+00	e	1.04E+01	e
Terbutryn	886-50-0	2.07E-02	e	1.24E-01	e	2.36E+00	e	5.67E+00	e
Toxaphene	8001-35-2	1.20E-02	RE	9.30E-02	RE	2.24E+01	RE	5.38E+01	RE
Triallate	2303-17-5	3.24E-02	e	2.17E-01	e	5.35E+00	e	1.28E+01	e
2,4,5-Trichlorophenoxy acetic acid (2,4,5-T)	93-76-5	8.42E-03	e	5.17E-02	e	2.82E+00	e	6.76E+00	e
Trifluralin	1582-09-8	6.73E-02	e	4.74E-01	e	7.93E+00	e	1.90E+01	e
Warfarin	81-81-2	3.84E-03	e	2.59E-02	e	5.60E+00	e	1.35E+01	e
Metals									
Aluminum	7429-90-5	1.00E-03	RE	NA	NA	NA	NA	NA	NA
Antimony	7440-36-0	1.00E-03	RE	NA	NA	NA	NA	NA	NA
Arsenic	7440-38-2	1.00E-03	RE	NA	NA	NA	NA	NA	NA
Barium	7440-39-3	1.00E-03	RE	NA	NA	NA	NA	NA	NA
Beryllium	7440-41-7	1.00E-03	RE	NA	NA	NA	NA	NA	NA
Cadmium	7440-43-9	1.00E-03	RE	NA	NA	NA	NA	NA	NA
Chromium (III) total chromium	7440-47-3	1.00E-03	RE	NA	NA	NA	NA	NA	NA
Chromium (VI)	18540-29-9	2.00E-03	RE	NA	NA	NA	NA	NA	NA
Copper	7440-50-8	1.00E-03	RE	NA	NA	NA	NA	NA	NA
Lead	7439-92-1	NA	NA	NA	NA	NA	NA	NA	NA
Manganese	7439-96-5	1.00E-03	RE	NA	NA	NA	NA	NA	NA
Mercury	7439-97-6	1.00E-03	RE	NA	NA	NA	NA	NA	NA
Molybdenum	7439-98-7	1.00E-03	RE	NA	NA	NA	NA	NA	NA
Nickel	7440-02-0	2.00E-04	RE	NA	NA	NA	NA	NA	NA
Selenium	7782-49-2	1.00E-03	RE	NA	NA	NA	NA	NA	NA
Silver	7440-22-4	6.00E-04	RE	NA	NA	NA	NA	NA	NA
Strontium	7440-24-6	1.00E-03	RE	NA	NA	NA	NA	NA	NA
Thallium chloride	7791-12-0	1.00E-03	RE	NA	NA	NA	NA	NA	NA

Table E-2
Parameters for Dermal Contact Pathway

Chemicals	CAS #	Permeability Constant, K_p (cm/hr)	Relative Contribution of Permeability Coefficient, B (unitless)	Lag Time, τ_{event} (hr/event)	Duration of Event, t^* (hr)	Fraction Absorbed Water, FA (unitless)
Vanadium	7440-62-2	1.00E-03	RE	NA	NA	NA
Zinc	7440-66-6	6.00E-04	RE	NA	NA	NA
Inorganics						
Ammonia	7664-41-7	1.00E-03	RE	NA	NA	NA
Cyanide	57-12-5	1.00E-03	RE	NA	NA	NA
Cyanide (as Sodium Cyanide)	143-33-9	1.00E-03	RE	NA	NA	NA
Cyanogen bromide	506-68-3	1.00E-03	RE	NA	NA	NA
Fluoride (as Sodium Fluoride)	7681-49-4	1.00E-03	RE	NA	NA	NA
Perchlorate	14797-73-0	1.00E-03	RE	NA	NA	NA
White phosphorus	7723-14-0	1.00E-03	RE	NA	NA	NA
Total Petroleum Hydrocarbons						
TPH-GRO						
Aliphatics - > C6-C8	NA	NA	NA	NA	NA	NA
Aliphatics - > C8-C10	NA	NA	NA	NA	NA	NA
Aromatics - >C8-C10	NA	NA	NA	NA	NA	NA
TPH-DRO						
Aliphatics - >C10-C12	NA	NA	NA	NA	NA	NA
Aliphatics - >C12-C16	NA	NA	NA	NA	NA	NA
Aliphatics - >C16-C21	NA	NA	NA	NA	NA	NA
Aromatics - >C10-C12	NA	NA	NA	NA	NA	NA
Aromatics - >C12-C16	NA	NA	NA	NA	NA	NA
Aromatics - >C16-C21	NA	NA	NA	NA	NA	NA
TPH-ORO						
Aliphatics - >C21-C35	NA	NA	NA	NA	NA	NA
Aromatics - >C21-C35	NA	NA	NA	NA	NA	NA

Notes:

e - Estimated by RAGS Part E

RE - RAGS Part E

NA - Not available

Chemicals in MRBCA Process for Petroleum Storage Tanks

Table E-3
Physical and Chemical Properties of Chemicals

Chemicals	CAS #	MCL (mg/L)	Molecular Weight, MW (g/mol)	Water Solubility, S (mg/L)	Henry's Law Constant, H (L-water/L-air)	Organic Carbon Adsorption Coefficient, K _{oc} (cm ³ /g)	Soil-Water Partition Coefficient, K _d (L/kg)	Diffusion Coefficient in Air, D _a (cm ² /s)	Diffusion Coefficient in Water, D _w (cm ² /s)	Vapor Pressure, P (mmHg)	Octanol-Water Partition Coefficient, K _{ow} (cm ³ /g)
VOCs and SVOCs											
Acenaphthene	83-32-9		154	4.24E+00	6.36E-03	7.08E+03	NA	4.21E-02	7.69E-06	3.75E-03	1.41E+04
Acenaphthylene	208-96-8		152	3.93E+00	4.74E-03	6.92E+03	NA	4.39E-02	7.07E-06	2.90E-02	8.63E+03
Acetone	67-64-1		58	1.00E+06	1.59E-03	5.75E-01	NA	1.24E-01	1.14E-05	2.27E+02	5.80E-01
Acetonitrile	75-05-8		41	1.00E+06	1.41E-03	1.56E+01	NA	1.30E-01	1.70E-05	9.00E+01	4.57E-01
Acrylamide	79-06-1		71	6.40E+05	4.10E-08	5.00E+01	NA	9.70E-02	1.28E-05	7.00E-03	1.56E-01
Acrylic acid	79-10-7		72	1.00E+06	4.80E-06	1.13E+00	NA	9.08E-02	1.06E-05	3.72E+00	2.77E+00
Acrylonitrile	107-13-1		53	7.45E+04	5.66E-03	8.50E-01	NA	1.08E-01	1.34E-05	1.10E+02	1.62E+00
Allyl alcohol	107-18-6		58	3.17E+05	2.05E-04	2.95E+01	NA	1.14E-01	1.10E-05	2.63E+01	1.48E+00
Allyl chloride	107-05-1		81	1.00E+06	3.12E-05	5.00E+01	NA	9.80E-02	1.08E-05	3.60E+02	8.51E+01
Aniline	62-53-3		93	3.60E+04	5.82E-05	9.12E+00	NA	7.00E-02	8.30E-06	6.69E-01	1.20E+01
Anthracene	120-12-7		178.24	4.34E-02	2.95E-02	2.95E+04	NA	3.24E-02	7.74E-06	2.55E-05	2.24E+04
Aroclor 1016	12674-11-2		258	4.20E-01	1.19E-02	1.80E+05	NA	1.92E-02	6.60E-06	4.00E-04	3.98E+05
Aroclor 1221	11104-28-2		201	5.90E-01	1.41E-01	5.80E+03	NA	2.85E-02	7.00E-06	6.70E-03	5.01E+04
Aroclor 1242	53469-21-9		267	3.40E-01	2.10E-02	6.30E+03	NA	1.86E-02	6.50E-06	4.06E-04	3.98E+05
Aroclor 1248	12672-29-6		300	6.00E-02	1.13E-01	2.77E+05	NA	1.56E-02	6.10E-06	4.94E-04	1.58E+06
Aroclor 1254	11097-69-1		327	5.70E-02	8.20E-02	5.30E+05	NA	1.56E-02	5.00E-06	7.71E-05	3.16E+06
Aroclor 1260	11096-82-5		376	8.00E-02	1.85E-01	6.70E+06	NA	1.16E-02	6.00E-06	4.05E-05	6.31E+06
Azobenzene	103-33-3		182	1.60E+00	1.89E-03	5.32E+04	NA	4.96E-02	6.36E-06	3.02E-04	5.86E+04
Benzene	71-43-2	0.005	78	1.75E+03	2.28E-01	5.89E+01	NA	8.80E-02	9.80E-06	9.50E+01	9.77E+01
Benzidine	92-87-5		184	3.22E+02	1.59E-09	1.74E+05	NA	3.40E-02	1.50E-05	8.36E-08	2.19E+01
Benzo(a)anthracene	56-55-3		228	9.40E-03	1.37E-04	3.98E+05	NA	5.10E-02	9.00E-06	1.54E-07	3.31E+05
Benzo(a)pyrene	50-32-8	0.0002	252	1.62E-03	4.63E-05	1.02E+06	NA	4.30E-02	9.00E-06	4.89E-09	1.29E+06
Benzo(b)fluoranthene	205-99-2		252	1.50E-03	4.55E-03	1.23E+06	NA	2.26E-02	5.56E-06	8.06E-08	1.29E+06
Benzo(g,h,i)perylene	191-24-2		276	2.60E-04	5.82E-06	1.58E+06	NA	4.90E-02	5.65E-05	1.00E-10	5.01E+06
Benzo(k)fluoranthene	207-08-9		252.32	8.00E-04	3.40E-05	1.23E+06	NA	2.26E-02	5.56E-06	9.59E-11	1.29E+06
Benzoic acid	65-85-0		122	3.50E+03	6.31E-05	6.00E-01	NA	5.36E-02	7.97E-06	6.51E-03	7.41E+01
Benzyl alcohol	100-51-6		108	4.00E+04	1.62E-05	1.20E+01	NA	8.00E-02	8.00E-06	1.06E-01	1.20E+01
1,1-Biphenyl	92-52-4		154	6.94E+00	1.67E-02	1.40E+03	NA	4.04E-02	8.20E-06	2.94E+02	5.71E+03
Bis(2-chloroethyl)ether	111-44-4		143	1.72E+04	7.38E-04	1.55E+01	NA	6.90E-02	7.53E-06	1.34E+00	3.63E+01
Bis(2-chloroisopropyl)ether	108-60-1		171	1.70E+03	4.60E-03	5.70E+01	NA	6.30E-02	6.40E-06	8.50E-01	3.80E+02
Bis(chloromethyl) ether	542-88-1		115	2.20E+04	8.45E-03	1.20E+00	NA	8.87E-02	9.40E-06	3.00E+01	3.76E+00
Bis(2-ethylhexyl)phthalate	117-81-7	0.006	391	3.40E-01	4.18E-06	1.51E+07	NA	3.51E-02	3.66E-06	6.45E-06	2.45E+08
Bromochloromethane	74-97-5		129	2.40E+04	3.69E-02	2.75E+01	NA	9.65E-02	1.12E-05	1.06E+02	2.09E+01
Bromodichloromethane	75-27-4	0.08	164	6.74E+03	6.56E-02	5.50E+01	NA	2.98E-02	1.06E-05	5.84E+01	4.07E+01
Bromoform	75-25-2	0.08	253	3.10E+03	2.19E-02	8.71E+01	NA	1.49E-02	1.03E-05	5.60E+00	6.17E+01
Bromomethane	74-83-9		95	1.50E+04	2.60E-01	9.00E+00	NA	7.30E-02	1.20E-05	1.64E+03	1.51E+01
4-Bromophenyl phenyl ether	101-55-3		249	1.45E+00	4.80E-03	1.70E+04	NA	4.75E-02	6.28E-06	5.85E-04	1.78E+05
n-Butylbenzene	104-51-8		130	1.40E+01	5.40E-01	2.80E+03	NA	7.50E-02	7.80E-06	8.14E-01	1.95E+04
sec-Butylbenzene	135-98-8		130	1.70E+01	7.70E-01	2.20E+03	NA	7.50E-02	7.80E-06	1.25E+00	1.23E+04
tert-Butylbenzene	98-06-6		130	3.00E+01	5.00E-01	2.20E+03	NA	7.50E-02	7.80E-06	1.76E+00	1.51E+04
Butyl benzyl phthalate	85-68-7		312	2.69E+00	5.17E-05	5.75E+04	NA	1.74E-02	4.83E-06	1.20E-05	6.92E+04

Table E-3
Physical and Chemical Properties of Chemicals

Chemicals	CAS #	MCL (mg/L)	Molecular Weight, MW (g/mol)	Water Solubility, S (mg/L)	Henry's Law Constant, H (L-water/L-air)	Organic Carbon Adsorption Coefficient, K _{oc} (cm ³ /g)	Soil-Water Partition Coefficient, K _d (L/kg)	Diffusion Coefficient in Air, D _a (cm ² /s)	Diffusion Coefficient in Water, D _w (cm ² /s)	Vapor Pressure, P (mmHg)	Octanol-Water Partition Coefficient, K _{ow} (cm ³ /g)
Carbazole	86-74-8		167	7.48E+00	6.27E-07	3.39E+03	NA	3.90E-02	7.03E-06	2.66E-04	1.70E+03
Carbon disulfide	75-15-0		76	1.19E+03	1.24E+00	4.57E+01	NA	1.04E-01	1.00E-05	3.40E+02	8.71E+01
Carbon tetrachloride	56-23-5	0.005	154	7.93E+02	1.25E+00	1.74E+02	NA	7.80E-02	8.80E-06	1.12E+02	2.75E+02
p-Chloroaniline	106-47-8		128	5.30E+03	1.36E-05	6.61E+01	NA	4.83E-02	1.01E-05	2.35E-02	5.25E+01
Chlorobenzene	108-90-7		113	4.72E+02	1.52E-01	2.19E+02	NA	7.30E-02	8.70E-06	1.21E+01	4.37E+02
Chloroethane	75-00-3		65	5.70E+03	4.50E-01	1.50E+01	NA	1.00E-01	1.20E-05	1.20E+03	3.80E+01
Chloroform	67-66-3	0.08	119	7.92E+03	1.52E-01	3.98E+01	NA	1.04E-01	1.00E-05	1.98E+02	3.31E+01
Chloromethane	74-87-3		51	8.20E+03	9.80E-01	3.50E+01	NA	1.10E-01	6.50E-06	3.77E+03	1.23E+01
2-Chloronaphthalene	91-58-7		160	1.20E+01	1.30E-02	1.60E+03	NA	2.50E-02	8.80E-06	1.70E-02	6.51E+03
2-Chlorophenol	95-57-8		129	2.20E+04	1.60E-02	3.88E+02	NA	5.01E-02	9.46E-06	1.42E+00	1.45E+02
4-Chlorophenyl phenyl ether	7005-72-3		205	1.43E+00	1.30E-02	1.31E+04	NA	4.89E-02	6.19E-06	1.66E-03	1.10E+05
2-Chlorotoluene	95-49-8		127	1.54E+02	1.35E-01	4.07E+02	NA	7.01E-02	8.01E-06	3.90E-03	1.59E+03
4-Chlorotoluene	106-43-4		127	1.18E+02	1.33E-01	4.96E+02	NA	6.76E-02	7.96E-06	2.27E+00	2.02E+03
Chrysene	218-01-9		228.3	1.60E-03	3.88E-03	3.98E+05	NA	2.48E-02	6.21E-06	7.80E-09	3.31E+05
Dibenzo(a,h)anthracene	53-70-3		278.4	2.49E-03	6.03E-07	3.80E+06	NA	2.02E-02	5.18E-06	2.10E-11	5.01E+06
Dibenzofuran	132-64-9		168	4.22E+00	8.73E-03	7.76E+03	NA	6.01E-02	1.00E-05	1.64E-03	9.92E+03
Dibromochloromethane	124-48-1	0.08	208	2.60E+03	3.21E-02	6.31E+01	NA	1.96E-02	1.05E-05	1.50E+01	5.01E+01
1,2-Dibromo-3-chloropropane	96-12-8	0.0002	236	1.23E+03	6.03E-03	2.80E+01	NA	7.00E-06	7.00E-06	7.60E-01	4.79E+02
Dibutyl phthalate	84-74-2		278	1.12E+01	3.85E-08	3.39E+04	NA	4.38E-02	7.86E-06	4.25E-05	4.07E+04
1,2-Dichlorobenzene	95-50-1	0.6	147	1.56E+02	7.79E-02	6.17E+02	NA	6.90E-02	7.90E-06	1.36E+00	1.91E+03
1,3-Dichlorobenzene	541-73-1		150	1.60E+02	7.80E-02	6.20E+02	NA	6.90E-02	7.90E-06	2.30E+00	1.91E+03
1,4-Dichlorobenzene	106-46-7	0.075	147	7.38E+01	9.96E-02	6.17E+02	NA	6.90E-02	7.90E-06	1.06E+00	1.91E+03
3,3-Dichlorobenzidine	91-94-1		253	3.11E+00	1.64E-07	7.24E+02	NA	1.94E-02	6.74E-06	2.20E-07	1.62E+03
Dichlorodifluoromethane	75-71-8		120	2.80E+02	4.10E+00	5.80E+01	NA	8.00E-02	1.10E-05	4.80E+03	6.54E+01
1,1-Dichloroethane	75-34-3		99	5.10E+03	2.30E-01	3.20E+01	NA	7.40E-02	1.10E-05	2.28E+02	5.75E+01
1,1-Dichloroethylene	75-35-4	0.007	97	2.25E+03	1.07E+00	5.89E+01	NA	9.00E-02	1.04E-05	5.91E+02	1.32E+02
cis-1,2-Dichloroethylene	156-59-2	0.07	97	3.50E+03	1.67E-01	3.55E+01	NA	7.36E-02	1.13E-05	1.75E+02	7.24E+01
trans-1,2-Dichloroethylene	156-60-5	0.1	97	6.30E+03	3.85E-01	5.25E+01	NA	7.07E-02	1.19E-05	3.52E+02	1.18E+02
2,4-Dichlorophenol	120-83-2		163	4.50E+03	1.30E-04	1.47E+02	NA	3.46E-02	8.77E-06	7.15E-02	6.31E+02
1,2-Dichloropropane	78-87-5	0.005	113	2.80E+03	1.15E-01	4.37E+01	NA	7.82E-02	8.73E-06	5.00E+01	1.78E+02
1,3-Dichloropropene	542-75-6		111	2.80E+03	7.26E-01	4.57E+01	NA	6.26E-02	1.00E-05	3.12E+01	5.62E+01
Di(2-ethylhexyl)adipate	103-23-1	0.4	371	1.71E-03	9.78E-01	3.80E+05	NA	3.56E-02	3.72E-06	8.25E-05	1.30E+08
Diethyl phthalate	84-66-2		222	1.08E+03	1.85E-05	2.88E+02	NA	2.56E-02	6.35E-06	1.65E-03	4.42E+02
Diisopropyl ether (DIPE)	108-20-3		102	2.67E+03	1.63E-01	6.46E+01	NA	6.81E-02	7.15E-06	7.76E+01	1.55E+02
2,4-Dimethylphenol	105-67-9		122	7.87E+03	8.20E-05	2.09E+02	NA	5.84E-02	8.69E-06	1.26E-01	4.07E+02
2,6-Dimethylphenol	576-26-1		122	6.05E+03	2.73E-04	1.60E+03	NA	5.84E-02	8.69E-06	NA	NA
Dimethyl phthalate	131-11-3		194	4.00E+03	4.31E-06	4.00E+01	NA	5.68E-02	6.30E-06	9.12E-03	4.57E+01
1,3-Dinitrobenzene	99-65-0		168	5.33E+01	1.53E-05	1.06E+02	NA	2.80E-01	7.60E-06	2.49E-04	4.27E+01
2,4-Dinitrophenol	51-28-5		184	2.79E+03	1.82E-05	1.00E-02	NA	2.73E-02	9.06E-06	1.14E-04	5.37E+01
2,4-Dinitrotoluene	121-14-2		182	2.70E+02	3.80E-06	9.55E+01	NA	2.03E-01	7.06E-06	1.74E-04	1.50E+02
2,6-Dinitrotoluene	606-20-2		182	1.82E+02	3.06E-05	6.92E+01	NA	3.27E-02	7.26E-06	5.70E-04	1.50E+02
4-Amino-2,6-dinitrotoluene	19406-51-0		197	3.64E+01	1.74E-07	3.63E+02	NA	5.60E-02	7.31E-06	5.86E-07	4.17E+02

Table E-3
Physical and Chemical Properties of Chemicals

Chemicals	CAS #	MCL (mg/L)	Molecular Weight, MW (g/mol)	Water Solubility, S (mg/L)	Henry's Law Constant, H (L-water/L-air)	Organic Carbon Adsorption Coefficient, K _{oc} (cm ³ /g)	Soil-Water Partition Coefficient, K _d (L/kg)	Diffusion Coefficient in Air, D _a (cm ² /s)	Diffusion Coefficient in Water, D _w (cm ² /s)	Vapor Pressure, P (mmHg)	Octanol-Water Partition Coefficient, K _{ow} (cm ³ /g)
2-Amino-4,6-dinitrotoluene	35572-78-2		197	1.73E+01	1.19E-07	5.62E+02	NA	5.60E-02	7.30E-06	1.19E-07	6.31E+02
Di-n-octylphthalate	117-84-0		391	2.00E-02	2.74E-03	2.39E+03	NA	1.51E-02	3.58E-06	4.47E-06	3.64E+08
1,4-Dioxane	123-91-1		88	1.00E+06	1.97E-04	1.70E+01	NA	2.30E-01	1.00E-05	3.80E+01	4.79E-01
Diphenylamine	122-39-4		169	5.30E+01	1.39E-04	6.00E+02	NA	6.08E-02	6.30E-06	4.26E-03	1.96E+03
1,2-Diphenylhydrazine	122-66-7		184	1.84E+03	1.42E-07	6.61E+02	NA	5.62E-02	5.70E-06	2.60E-05	1.14E+03
Ethanol	64-17-5		46	2.96E+05	2.77E-04	1.19E+00	NA	1.15E-01	1.22E-05	7.76E+01	9.95E-01
Ethylbenzene	100-41-4	0.7	106	1.69E+02	3.23E-01	3.63E+02	NA	7.50E-02	7.80E-06	9.60E+00	1.07E+03
Ethylene dibromide (EDB)	106-93-4	0.00005	188	4.32E+03	2.93E-02	5.37E+01	NA	2.17E-02	1.90E-05	1.10E+01	1.02E+02
Ethylene dichloride (EDC)	107-06-2	0.005	99	8.52E+03	4.01E-02	1.74E+01	NA	1.04E-01	9.90E-06	8.13E+01	6.76E+01
Ethylene glycol	107-21-1		62	1.00E+06	2.46E-06	4.00E+00	NA	1.08E-01	1.22E-05	7.00E-02	6.31E-02
Ethylenethiourea	96-45-7		102	2.00E+04	1.26E-08	1.00E+01	NA	7.15E-02	1.02E-05	8.36E-02	3.23E-01
Ethyl-tert-butyl-ether (ETBE)	637-92-3		102	5.03E+03	9.99E-02	3.72E+01	NA	6.95E-02	7.34E-06	9.00E+01	7.59E+01
Fluoranthene	206-44-0		202	2.06E-01	6.60E-04	1.07E+05	NA	3.02E-02	6.35E-06	8.13E-06	8.51E+04
Fluorene	86-73-7		166	1.98E+00	2.61E-03	1.38E+04	NA	3.63E-02	7.88E-06	3.24E-03	1.05E+04
Formaldehyde	50-00-0		30	4.00E+05	1.38E-05	2.19E+00	NA	1.80E-01	2.00E-05	3.88E+03	2.24E+00
n-Hexane	110-54-3		86	9.50E+00	7.38E+01	8.90E+02	NA	2.00E-01	7.77E-06	1.52E+02	1.95E+03
Hexachlorobenzene	118-74-1	0.001	285	6.20E+00	5.41E-02	5.50E+04	NA	5.42E-02	5.91E-06	1.23E-05	7.24E+05
Hexachlorobutadiene	87-68-3		261	3.23E+00	3.34E-01	5.37E+04	NA	5.61E-02	6.16E-06	1.77E-01	5.21E+04
Hexachlorocyclopentadiene	77-47-4	0.05	273	1.80E+00	1.11E+00	2.00E+05	NA	1.61E-02	7.21E-06	7.32E-02	4.22E+04
Hexachloroethane	67-72-1		237	5.00E+01	1.59E-01	1.78E+03	NA	2.50E-03	6.80E-06	4.72E-01	1.08E+04
Hexachlorophene	70-30-4		407	1.40E+02	2.25E-11	5.00E+03	NA	8.00E-02	8.00E-06	2.74E-12	8.36E+06
HMX	2691-41-0		296	1.40E+02	3.55E-08	3.70E+01	NA	3.74E-02	6.34E-06	4.75E-15	5.00E-02
Indeno(1,2,3-cd)pyrene	193-39-5		276	2.20E-05	6.56E-05	3.47E+06	NA	1.90E-02	5.66E-06	1.40E-10	4.98E+06
Isophorone	78-59-1		138	1.20E+04	2.72E-04	4.68E+01	NA	6.23E-02	6.76E-06	4.10E-01	4.15E+02
Isopropylbenzene (Cumene)	98-82-8		120	6.13E+01	3.57E+00	4.54E+02	NA	7.50E-02	7.10E-06	4.60E+00	2.82E+03
4-Isopropyltoluene	99-87-6		134	1.72E+01	4.66E-01	2.29E+03	NA	5.72E-02	6.73E-06	1.08E+00	1.38E+04
Maleic anhydride	108-31-6		98	4.91E+03	1.61E-04	2.57E+01	NA	9.50E-02	1.11E-05	1.34E-03	4.17E+01
Methanol	67-56-1		32	1.00E+06	1.87E-04	9.00E+00	NA	1.50E-01	1.64E-05	1.22E+02	2.33E-01
Methyl butyl ketone	591-78-6		100	1.79E+04	3.38E-03	1.79E+01	NA	6.96E-02	7.75E-06	1.11E+01	3.04E+01
Methyl ethyl ketone	78-93-3		72	2.23E+05	2.33E-03	4.50E+00	NA	8.95E-02	9.80E-06	9.10E+01	1.80E+00
2-Methyl-4,6-dinitrophenol	534-52-1		198	3.00E+03	1.07E-07	3.16E-02	NA	5.31E-02	7.27E-06	2.87E-05	1.17E+02
Methylene chloride	75-09-2	0.005	85	1.30E+04	8.98E-02	1.17E+01	NA	1.01E-01	1.17E-05	4.55E+02	2.19E+01
Methyl iodide	74-88-4		142	1.39E+04	2.16E-01	1.58E+02	NA	1.02E-01	1.17E-05	3.79E+02	3.55E+01
Methyl isobutyl ketone	108-10-1		100	1.90E+04	5.66E-03	1.34E+02	NA	7.50E-02	7.80E-06	1.45E+02	1.45E+01
2-Methylnaphthalene	91-57-6		142	2.54E+01	1.85E-02	4.32E+03	NA	6.29E-02	7.20E-06	6.57E-02	5.20E+03
2-Methylphenol	95-48-7		108	2.60E+04	4.92E-05	9.12E+01	NA	7.40E-02	8.30E-06	3.20E-01	1.15E+02
3-Methylphenol	108-39-4		108	2.27E+04	3.55E-05	3.46E+01	NA	7.40E-02	1.00E-05	1.40E-01	1.15E+02
4-Methylphenol	106-44-5		108	2.15E+04	4.10E-05	4.90E+01	NA	7.40E-02	1.00E-05	1.30E-01	1.15E+02
Methyl tertiary butyl ether (MTBE)	1634-04-4		88	5.10E+04	2.41E-02	1.12E+01	NA	8.00E-02	1.00E-05	2.49E+02	7.59E+01
Methyl-2,4,6-trinitrophenylnitramine	479-45-8		287	7.50E+01	8.31E-11	2.34E+02	NA	5.69E-02	6.40E-06	4.00E-10	1.10E+02
Naphthalene	91-20-3		128	3.10E+01	1.98E-02	2.00E+03	NA	5.90E-02	7.50E-06	8.89E-02	1.48E+03
2-Nitroaniline	88-74-4		138	1.26E+03	2.08E-05	2.69E+01	NA	5.99E-02	7.18E-06	4.75E-03	1.05E+02

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Chemicals	CAS #	MCL (mg/L)	Molecular Weight, MW (g/mol)	Water Solubility, S (mg/L)	Henry's Law Constant, H (L-water/L-air)	Organic Carbon Adsorption Coefficient, K _{oc} (cm ³ /g)	Soil-Water Partition Coefficient, K _d (L/kg)	Diffusion Coefficient in Air, D _a (cm ² /s)	Diffusion Coefficient in Water, D _w (cm ² /s)	Vapor Pressure, P (mmHg)	Octanol-Water Partition Coefficient, K _{ow} (cm ³ /g)
3-Nitroaniline	99-09-2		138	4.56E+02	2.31E-07	3.94E+01	NA	6.73E-02	8.59E-06	1.39E-05	4.17E+01
4-Nitroaniline	100-01-6		138	6.49E+02	3.33E-08	1.12E+01	NA	6.69E-02	8.59E-06	2.86E-06	1.18E+01
Nitrobenzene	98-95-3		123	2.09E+03	9.84E-04	6.46E+01	NA	7.60E-02	8.60E-06	2.44E-01	6.46E+01
Nitroglycerin	55-63-0		227	6.70E+04	3.40E-06	9.25E+01	NA	5.53E-02	7.34E-06	1.00E-04	1.00E+02
2-Nitrophenol	88-75-5		139	1.73E+04	2.21E-05	2.09E+01	NA	6.87E-02	8.47E-06	5.03E-02	2.23E+02
4-Nitrophenol	100-02-7		139	4.49E+03	3.24E-08	3.16E+00	NA	6.73E-02	8.66E-06	1.91E-05	5.33E+01
n-Nitrosodimethylamine	62-75-9		74	1.00E+06	7.46E-05	1.20E+01	NA	1.34E-01	9.72E-06	5.37E+00	2.30E-01
n-Nitrosodi-n-propylamine	621-64-7		130	9.89E+03	9.35E-05	2.00E+01	NA	5.45E-02	8.17E-06	4.00E-01	2.24E+01
n-Nitrosodiphenylamine	86-30-6		198	3.51E+01	2.05E-04	1.29E+03	NA	3.12E-02	6.35E-06	9.88E-02	1.45E+03
n-Nitrosopyrrolidine	930-55-2		100	7.80E+05	7.48E-07	6.50E-01	NA	8.00E-02	8.00E-06	1.75E-01	1.70E+00
2-Nitrotoluene	88-72-2		137	6.00E+02	1.87E-03	1.41E+02	NA	6.47E-02	7.73E-06	1.50E-01	2.28E+02
3-Nitrotoluene	99-08-1		137	4.98E+02	2.24E-03	1.41E+02	NA	6.42E-02	7.69E-06	1.50E-01	2.28E+02
4-Nitrotoluene	99-99-0		137	4.00E+02	2.29E-03	1.41E+02	NA	6.40E-02	7.70E-06	1.20E-01	2.28E+02
Pentachlorobenzene	608-93-5		250	1.33E+00	2.91E-02	4.00E+04	NA	6.70E-02	6.30E-06	1.67E-03	1.66E+05
Pentachloronitrobenzene	82-68-8		295	5.50E-01	3.28E-03	2.66E+04	NA	1.59E-02	6.10E-06	1.13E-04	1.07E+05
Pentachlorophenol	87-86-5	0.001	266	1.95E+03	1.00E-06	5.92E+02	NA	5.60E-02	6.10E-06	1.70E-05	5.50E+04
Pentaerythritol tetranitrate	78-11-5		316	2.66E+01	5.60E-05	6.29E+03	NA	4.48E-02	6.20E-06	8.63E-05	7.31E+03
Phenanthrene	85-01-8		178	9.94E-01	5.40E-03	1.41E+04	NA	3.33E-02	7.47E-06	6.80E-04	2.24E+04
Phenol	108-95-2		94	8.28E+04	1.63E-05	2.88E+01	NA	8.20E-02	9.10E-06	4.63E-01	3.24E+01
m-Phenylenediamine	108-45-2		108	2.38E+05	3.91E-09	1.10E+00	NA	6.63E-02	9.90E-06	2.28E-02	4.06E-01
Polychlorinated biphenyls (PCBs)	1336-36-3	0.0005	326	4.30E-02	1.16E-02	3.09E+05	NA	1.04E-01	1.00E-05	7.60E-05	2.00E+06
n-Propylbenzene	103-65-1		120	5.22E+01	4.31E-01	7.41E+02	NA	7.50E-02	7.80E-06	2.71E+00	5.37E+03
Pyrene	129-00-0		202	1.35E-01	4.51E-04	1.05E+05	NA	2.72E-02	7.24E-06	4.25E-06	8.51E+04
RDX	121-82-4		173	9.33E+02	2.28E-06	6.31E+01	NA	6.65E-02	6.39E-06	1.00E-09	7.41E+00
Styrene	100-42-5	0.1	104	3.10E+02	1.13E-01	7.76E+02	NA	7.10E-02	8.00E-06	6.24E+00	7.94E+02
1,1,1,2-Tetrachloroethane	630-20-6		168	1.10E+03	9.92E-02	7.90E+01	NA	7.10E-02	7.90E-06	1.22E+01	8.57E+02
1,1,2,2-Tetrachloroethane	79-34-5		168	2.97E+03	1.41E-02	9.33E+01	NA	7.10E-02	7.90E-06	5.17E+00	1.55E+02
1,2,4,5-Tetrachlorobenzene	95-94-3		216	3.00E-01	4.99E-02	1.60E+03	NA	2.11E-02	8.80E-06	5.40E-03	3.72E+04
Tetrachloroethylene	127-18-4	0.005	166	2.00E+02	7.54E-01	1.55E+02	NA	7.20E-02	8.20E-06	1.84E+01	9.23E+02
Tetrahydrofuran	109-99-9		72	1.00E+06	2.89E-03	9.50E-01	NA	9.80E-02	1.10E-05	1.59E+02	4.22E+00
Tertiary-amyl-methyl-ether (TAME)	994-05-8		102	4.29E+03	1.30E-01	4.17E+01	NA	6.99E-02	7.37E-06	9.97E+01	8.91E+01
Tertiary-butyl-alcohol (TBA)	75-65-0		74	2.35E+05	5.42E-04	4.22E+00	NA	8.52E-02	9.11E-06	3.14E+01	4.90E+00
Toluene	108-88-3	1	92	5.26E+02	2.72E-01	1.82E+02	NA	8.70E-02	8.60E-06	2.82E+01	3.47E+02
1,2,4-Trichlorobenzene	120-82-1	0.07	181	3.00E+02	5.80E-02	1.78E+03	NA	3.00E-02	8.20E-06	3.36E+01	8.44E+03
1,3,5-Trichlorobenzene	108-70-3		181	6.01E+00	8.98E-02	7.08E+02	NA	6.25E-02	7.66E-06	1.11E-01	1.55E+04
1,1,1-Trichloroethane	71-55-6	0.2	133	1.33E+03	7.05E-01	1.10E+02	NA	7.80E-02	8.80E-06	1.24E+02	4.79E+02
1,1,2-Trichloroethane	79-00-5	0.005	133	4.42E+03	3.74E-02	5.01E+01	NA	7.80E-02	8.80E-06	2.52E+01	1.02E+02
Trichloroethylene	79-01-6	0.005	131	1.10E+03	4.22E-01	1.66E+02	NA	7.90E-02	9.10E-06	7.20E+01	2.95E+02
Trichlorofluoromethane	75-69-4		90	2.05E+03	3.97E+00	1.60E+02	NA	8.70E-02	1.30E-05	6.87E+02	1.35E+02
2,4,5-Trichlorophenol	95-95-4		197	1.20E+03	1.78E-04	1.60E+03	NA	2.91E-02	7.03E-06	1.63E-02	2.79E+03
2,4,6-Trichlorophenol	88-06-2		197	8.00E+02	3.19E-04	3.81E+02	NA	3.18E-02	6.25E-06	1.18E-02	2.79E+03
1,2,3-Trichloropropane	96-18-4		147	1.75E+03	1.41E-02	5.10E+01	NA	7.10E-02	7.90E-06	3.70E+00	3.19E+02

Table E-3
Physical and Chemical Properties of Chemicals

Chemicals	CAS #	MCL (mg/L)	Molecular Weight, MW (g/mol)	Water Solubility, S (mg/L)	Henry's Law Constant, H (L-water/L-air)	Organic Carbon Adsorption Coefficient, K _{oc} (cm ³ /g)	Soil-Water Partition Coefficient, K _d (L/kg)	Diffusion Coefficient in Air, D _a (cm ² /s)	Diffusion Coefficient in Water, D _w (cm ² /s)	Vapor Pressure, P (mmHg)	Octanol-Water Partition Coefficient, K _{ow} (cm ³ /g)
1,1,2-Trichlorotrifluoroethane	76-13-1		187	1.70E+02	2.16E+01	3.72E+02	NA	2.88E-02	8.07E-06	3.60E+02	1.23E+03
1,2,4-Trimethylbenzene	95-63-6		120	5.70E+01	2.53E-01	3.72E+03	NA	7.50E-02	7.10E-06	1.59E+00	4.47E+03
1,3,5-Trimethylbenzene	108-67-8		120	4.82E+01	3.60E-01	8.19E+02	NA	7.50E-02	7.10E-06	2.13E+00	5.01E+03
1,3,5-Trinitrobenzene	99-35-4		213	2.78E+02	1.36E-08	1.41E+01	NA	8.00E-02	8.00E-06	9.90E-05	2.79E+01
2,4,6-Trinitrotoluene (TNT)	118-96-7		227	1.30E+02	1.87E-05	3.08E+02	NA	5.41E-02	6.57E-06	1.24E-04	9.85E+01
Vinyl chloride (for residential scenario)	75-01-4	0.002	63	2.76E+03	1.11E+00	1.86E+01	NA	1.06E-01	1.23E-06	2.80E+03	4.17E+01
Vinyl chloride (for occupational scenario)	75-01-4	0.002	63	2.76E+03	1.11E+00	1.86E+01	NA	1.06E-01	1.23E-06	2.80E+03	4.17E+01
Xylenes (total)	1330-20-7	10	106	1.61E+02	3.01E-01	4.07E+02	NA	7.00E-02	7.80E-06	8.06E+00	1.23E+03
Pesticides											
Acetochlor	34256-82-1		270	2.23E+02	2.86E-06	2.00E+02	NA	5.01E-02	6.00E-06	3.40E-08	3.00E+02
Acifluorfen	62476-59-9		362	2.50E+05	8.31E-13	1.13E+02	NA	1.45E-02	4.40E-06	9.75E-09	2.36E+00
Acrolein	107-02-8		56	2.10E+05	4.90E-03	2.10E+01	NA	1.10E-01	1.20E-05	2.65E+02	7.94E-01
Alachlor	15972-60-8	0.002	270	2.40E+02	3.41E-07	1.91E+02	NA	1.94E-02	5.83E-06	2.20E-05	2.34E+03
Aldicarb	116-06-3	0.003	190	6.03E+03	5.90E-08	1.60E+01	NA	3.05E-02	7.20E-06	2.90E-05	2.29E+01
Aldicarb sulfone	1646-88-4	0.003	222	7.80E+03	1.38E-07	3.00E+00	NA	5.55E-02	5.79E-06	9.00E-05	2.16E-01
Aldrin	309-00-2		365	1.80E-01	6.97E-03	2.45E+06	NA	1.32E-02	4.86E-06	1.67E-05	5.62E+06
Ametryn	834-12-8		227	1.85E+02	1.88E-07	3.89E+02	NA	4.24E-02	5.70E-06	1.81E-07	7.67E+02
Atrazine	1912-24-9	0.003	216	2.80E+01	1.83E-07	4.89E+02	NA	5.64E-02	5.58E-06	3.00E-07	6.60E+02
Baygon	114-26-1		209	1.86E+03	1.64E-05	1.60E+02	NA	5.67E-02	7.41E-06	NA	NA
Butylate	2008-41-5		217	4.60E+01	3.50E-03	1.26E+02	NA	4.89E-02	5.14E-06	1.30E-02	7.13E+03
Captan	133-06-2		301	3.30E+00	2.95E-04	1.98E+02	NA	1.83E-02	4.90E-06	7.50E-06	6.98E+01
Carbaryl	63-25-2		201	8.26E+01	5.37E-02	1.02E+02	NA	2.78E-02	5.60E-06	1.36E-06	2.24E+02
Carbofuran	1563-66-2	0.04	221	3.20E+01	1.27E-07	4.80E+01	NA	5.35E-02	5.40E-06	8.30E-06	2.00E+02
Carboxin	5234-68-4		235	1.99E+02	1.15E+01	8.46E+02	NA	4.48E-02	6.14E-06	4.82E-08	1.05E+03
Chloramben	133-90-4		206	7.00E+02	1.59E-05	1.90E+02	NA	5.71E-02	7.46E-06	1.94E-05	3.02E+02
Chlordane (technical)	12789-03-6		410	5.60E-02	1.99E-03	1.20E+05	NA	1.18E-02	4.37E-06	1.00E-05	3.98E+06
Chlordane, gamma	57-74-9	0.002	410	2.28E-02	4.11E-03	3.93E+05	NA	3.32E-02	4.65E-06	4.17E-06	9.25E+06
Chlorothalonil	1897-45-6		266	6.00E-01	8.20E-05	5.78E+03	NA	4.90E-02	6.57E-06	2.41E-06	2.88E+03
Chlorpyrifos	2921-88-2		351	4.00E-01	1.20E-04	1.86E+03	NA	4.85E-02	5.11E-06	1.87E-05	4.57E+04
Coumaphos	56-72-4		363	3.86E-01	2.17E-07	1.60E+04	NA	3.53E-02	4.81E-06	4.22E-09	1.82E+04
Cyanazine	21725-46-2		241	1.70E+02	1.05E+01	2.00E+02	NA	4.33E-02	5.83E-06	7.28E-09	5.25E+01
Dacthal	1861-32-1		332	2.20E-01	9.35E-06	4.68E+04	NA	4.20E-02	2.05E+00	1.13E-07	5.13E+04
Dalapon, sodium salt	75-99-0	0.2	143	7.43E+03	2.64E-06	2.30E+00	NA	6.98E-02	8.70E-06	1.30E-01	3.98E+01
DDD	72-54-8		320	9.00E-02	1.64E-04	1.00E+06	NA	1.69E-02	4.76E-06	8.66E-07	7.47E+05
DDE	72-55-9		318	1.20E-01	8.61E-04	4.47E+06	NA	1.44E-02	5.87E-06	5.66E-06	9.90E+05
DDT	50-29-3		354	2.50E-02	3.32E-04	2.63E+06	NA	1.37E-02	4.95E-06	3.93E-07	6.23E+06
DEF	78-48-8		315	2.30E+00	1.20E-05	3.16E+05	NA	1.45E-02	5.90E-06	1.38E-05	5.01E+05
Demeton	8065-48-3		258	7.20E+02	6.65E-03	2.69E+02	NA	4.56E-02	5.45E-06	1.00E-04	9.33E+02
Diazinon	333-41-5		304	4.00E+01	4.63E-06	2.29E+02	NA	1.80E-02	4.90E-06	8.40E-05	7.31E+03
Dicamba	1918-00-9		221	4.50E+03	8.94E-08	1.15E+02	NA	6.02E-02	6.69E-06	9.70E-05	1.38E+02
2,4-Dichlorophenoxy acetic acid (2,4-D)	94-75-7	0.07	221	6.77E+02	4.18E-07	8.91E+02	NA	5.90E-02	6.50E-06	2.40E-05	4.14E+02
4-(2,4-Dichlorophenoxy) butyric acid (2,4-DB)	94-82-6		249	5.30E+01	9.39E-08	5.30E+02	NA	4.41E-02	6.13E-06	1.82E-07	6.12E+03

Table E-3
Physical and Chemical Properties of Chemicals

Chemicals	CAS #	MCL (mg/L)	Molecular Weight, MW (g/mol)	Water Solubility, S (mg/L)	Henry's Law Constant, H (L-water/L-air)	Organic Carbon Adsorption Coefficient, K _{oc} (cm ³ /g)	Soil-Water Partition Coefficient, K _d (L/kg)	Diffusion Coefficient in Air, D _a (cm ² /s)	Diffusion Coefficient in Water, D _w (cm ² /s)	Vapor Pressure, P (mmHg)	Octanol-Water Partition Coefficient, K _{ow} (cm ³ /g)
Dichloroprop (2,4-DP)	120-36-5		235	2.30E+02	9.00E-07	2.86E-02	NA	4.70E-02	6.43E-06	1.60E-05	1.83E+03
Dieldrin	60-57-1		381	1.95E-01	6.19E-04	2.14E+04	NA	1.25E-02	4.74E-06	9.96E-07	2.82E+05
Dimethoate	60-51-5		229	2.38E+04	4.31E-09	2.70E+01	NA	8.00E-02	8.00E-06	5.09E-06	1.90E+00
2,4-Dinitro-6-sec-butylphenol (Dinoseb)	88-85-7	0.007	240	5.20E+01	1.87E-05	1.24E+02	NA	2.25E-02	6.25E-06	7.52E-02	4.71E+03
Diquat	85-00-7	0.02	344	7.08E+04	5.82E-12	2.04E+02	NA	5.52E-02	5.52E-06	1.00E-07	1.51E-03
Disulfoton	298-04-4		274	1.63E+01	1.64E-04	1.60E+00	NA	8.00E-02	8.00E-06	2.30E-04	7.24E+03
Diuron	330-54-1		233	4.20E+01	1.11E-04	3.80E+02	NA	5.40E-02	5.30E-06	1.00E-07	4.71E+02
Endosulfan	115-29-7		407	5.10E-01	4.59E-04	2.14E+03	NA	1.15E-02	4.55E-06	9.96E-06	6.92E+03
Endothall	145-73-3	0.1	186	1.00E+05	1.48E-13	1.23E+02	NA	5.72E-02	7.50E-06	1.80E-04	7.76E+01
Endrin	72-20-8	0.002	381	2.50E-01	3.08E-04	1.23E+04	NA	1.25E-02	4.74E-06	5.84E-07	2.82E+05
Endrin aldehyde	74-21-93-4		381	1.68E-02	1.80E-02	2.14E+06	NA	2.97E-02	3.83E-06	1.46E-05	2.75E+06
Endrin Ketone	53494-70-5		381	8.60E-01	3.66E-05	1.74E+05	NA	3.10E-02	4.46E-06	1.51E-06	2.14E+05
Eptam	759-94-4		189	3.70E+02	4.57E-03	2.40E+02	NA	5.35E-02	5.65E-06	1.60E-01	1.04E+03
Ethoprop	13194-48-4		242	7.50E+02	6.73E-06	1.22E+03	NA	4.16E-02	5.56E-06	3.80E-04	1.38E+03
Fenamiphos	22224-92-6		303	3.29E+02	4.96E-08	3.31E+02	NA	1.82E-02	4.88E-06	NA	NA
Fenthion	55-38-9		278	2.17E+01	2.13E-05	1.10E+03	NA	4.35E-02	5.42E-06	1.38E-04	1.15E+03
Fluometuron	2164-17-2		232	1.10E+02	7.38E-08	1.75E+02	NA	4.38E-02	5.66E-06	NA	NA
Fonofos	944-22-9		246	1.60E+01	2.21E-04	3.58E+03	NA	4.65E-02	5.52E-06	3.43E-01	1.00E+04
alpha-Hexachlorocyclohexane	319-84-6		291	2.00E+00	4.35E-04	1.23E+03	NA	1.42E-02	7.34E-06	4.26E-05	1.82E+04
beta-Hexachlorocyclohexane	319-85-7		291	2.40E-01	3.05E-05	1.26E+03	NA	1.42E-02	7.34E-06	4.90E-07	1.82E+04
delta-Hexachlorocyclohexane	319-86-8		291	3.14E+01	1.76E-05	4.26E+03	NA	4.50E-02	6.20E-06	2.87E-05	1.00E+04
gamma-Hexachlorocyclohexane	58-89-9	0.0002	291	6.80E+00	5.74E-04	1.07E+03	NA	1.42E-02	7.34E-06	3.72E-05	1.81E+04
Glyphosate	1071-83-6	0.7	169	1.20E+04	1.67E-17	3.63E+03	NA	5.07E-02	8.30E-06	7.50E-08	2.51E-02
Guthion	86-50-0		317	9.00E-02	8.80E-11	2.51E+02	NA	4.11E-02	5.34E-06	4.70E-09	3.16E+02
Heptachlor	76-44-8	0.0004	373	1.80E-01	6.10E+01	1.41E+06	NA	1.12E-02	5.69E-06	3.26E-04	1.61E+06
Heptachlor epoxide	1024-57-3	0.0002	389	2.00E-01	3.90E-04	8.32E+04	NA	1.32E-02	4.23E-06	4.34E-06	8.04E+04
Hexazinone	51235-04-2		252	3.30E+04	1.69E-11	3.72E+01	NA	5.08E-02	5.11E-06	2.03E-07	1.42E+02
Malathion	121-75-5		330	1.43E+02	9.84E-07	1.80E+03	NA	1.50E-02	4.40E-06	7.90E-06	1.94E+02
Maleic hydrazide	123-33-1		112	6.00E+03	1.09E-09	4.15E+01	NA	9.00E-02	1.11E-05	7.50E-08	1.30E-01
Maneb	12427-38-2		295	6.00E+00	2.31E-05	5.50E+02	NA	1.59E-02	6.10E-06	NA	NA
Methomyl	16752-77-5		162	5.80E+04	7.54E-09	1.50E+01	NA	6.93E-02	1.00E-05	5.00E-05	4.07E+00
Methoxychlor	72-43-5	0.04	346	4.50E-02	6.48E-04	9.77E+04	NA	1.56E-02	4.46E-06	1.23E-06	4.65E+05
2-Methyl-4-chlorophenoxyacetic acid (MCPA)	94-74-6		201	1.17E+03	5.45E-08	8.90E+01	NA	5.12E-02	6.82E-06	6.99E-06	2.45E+03
MCPP	93-65-2		215	2.80E+02	1.00E-06	1.73E-02	NA	4.70E-02	6.36E-06	2.50E-05	1.36E+03
Metolachlor	51218-45-2		284	5.30E+02	3.69E-07	7.03E+02	NA	3.61E-02	5.10E-06	2.29E-06	7.87E+02
Metribuzin	21087-64-9		214	1.22E+03	7.42E-11	9.50E+01	NA	4.51E-02	5.98E-06	5.16E-05	2.36E+00
Mirex	2385-85-5		546	3.28E+00	2.11E-02	5.57E+03	NA	3.50E-02	4.08E-06	7.50E-07	1.00E+11
Naled	300-76-5		381	2.00E+03	2.05E-05	1.33E+02	NA	4.40E-02	6.80E-06	2.00E-04	3.98E+01
o,o,o-Triethylphosphorothioate	126-68-1		198	8.45E+02	2.08E-02	4.90E+02	NA	5.26E-02	6.24E-06	7.30E-01	4.37E+02
Oxamyl	23135-22-0	0.2	219	2.80E+05	9.72E-09	8.00E+00	NA	5.57E-02	5.75E-06	3.83E-07	6.32E-02
Paraquat	4685-14-7		257	6.20E+05	4.10E-08	1.55E+04	NA	3.74E-02	3.57E-06	1.45E-06	3.16E-05
ethyl-Parathion	56-38-2		291	1.18E+01	2.37E-05	5.60E+03	NA	1.70E-02	5.80E-06	1.73E-05	5.38E+03

Table E-3
Physical and Chemical Properties of Chemicals

Chemicals	CAS #	MCL (mg/L)	Molecular Weight, MW (g/mol)	Water Solubility, S (mg/L)	Henry's Law Constant, H (L-water/L-air)	Organic Carbon Adsorption Coefficient, K _{oc} (cm ³ /g)	Soil-Water Partition Coefficient, K _d (L/kg)	Diffusion Coefficient in Air, D _a (cm ² /s)	Diffusion Coefficient in Water, D _w (cm ² /s)	Vapor Pressure, P (mmHg)	Octanol-Water Partition Coefficient, K _{ow} (cm ³ /g)
methyl-Parathion	298-00-0		263	3.70E+01	4.10E-06	5.10E+03	NA	8.00E-02	8.00E-06	1.52E-05	5.61E+02
Pendimethalin	40487-42-1		281	2.75E-01	3.51E-05	1.91E+05	NA	3.81E-02	5.26E-06	7.31E-07	2.34E+05
Phenylmercuric acetate	62-38-4		337	4.70E+03	2.32E-08	6.70E+01	NA	8.00E-02	8.00E-06	3.04E-06	7.76E+00
Phorate	298-02-2		260	5.00E+01	2.36E-04	6.61E+02	NA	8.00E-02	8.00E-06	1.30E-03	2.33E+03
Picloram	1918-02-1	0.5	241	4.30E+02	1.66E+02	2.60E+01	NA	5.50E-02	7.27E-06	2.15E-06	8.71E+02
Prometon	1610-18-0		225	7.50E+02	8.12E-08	5.25E+02	NA	4.25E-02	5.54E-06	3.43E-06	7.59E+02
Pronamide	23950-58-5		256	1.50E+01	7.83E-05	2.00E+02	NA	8.00E-02	8.00E-06	4.00E-04	3.76E+03
Propachlor	1918-16-7		212	6.13E+02	4.47E-06	2.63E+02	NA	8.03E-02	8.03E-06	NA	NA
Propanil	709-98-8		218	2.25E+02	1.85E-07	9.03E+02	NA	4.93E-02	6.59E-06	8.99E-07	9.43E+02
Propazine	139-40-2		230	8.60E+00	1.89E-07	1.55E+02	NA	4.40E-02	5.69E-06	1.23E-06	1.78E+03
Propham	122-42-9		179	3.20E+01	1.58E-06	8.90E+01	NA	5.71E-02	6.28E-06	1.35E-04	4.57E+02
Silvex (2,4,5-TP)	93-72-1	0.05	270	1.40E+02	3.71E-07	5.60E+01	NA	1.94E-02	5.80E-06	5.20E-06	4.78E+03
Simazine	122-34-9	0.004	202	5.70E+00	1.38E-07	1.38E+02	NA	4.90E-02	6.37E-06	9.10E-07	4.37E+02
Strychnine	57-24-9		334	1.60E+02	3.10E-12	7.94E+01	NA	8.00E-02	8.00E-06	1.67E-10	7.04E+01
Tebuthiuron	34014-18-1		228.31	2.50E+03	4.99E-11	3.13E+01	NA	5.62E-02	5.85E-06	2.03E-05	6.17E+01
Terbacil	5902-51-2		217	7.10E+02	4.92E-09	4.10E+01	NA	4.95E-02	6.61E-06	NA	NA
Terbufos	13071-79-9		288	5.07E+00	9.84E-04	6.61E+02	NA	4.18E-02	5.08E-06	2.96E-02	1.57E+04
Terbutryn	886-50-0		241	2.50E+01	1.30E-06	1.63E+03	NA	5.60E-02	6.00E-06	2.10E-06	5.50E+03
Toxaphene	8001-35-2	0.003	414	7.40E-01	2.46E-04	2.57E+05	NA	1.16E-02	4.34E-06	4.19E-06	6.24E+06
Triallate	2303-17-5		305	4.00E+00	7.91E-04	2.24E+03	NA	4.58E-02	4.84E-06	1.20E-04	3.72E+04
2,4,5-Trichlorophenoxyacetic acid (2,4,5-T)	93-76-5		255	2.78E+02	3.62E-07	5.30E+01	NA	8.00E-02	8.00E-06	3.61E-06	1.83E+03
Trifluralin	1582-09-8		335	8.11E+00	1.08E-03	1.38E+04	NA	1.49E-02	4.70E-06	1.10E-04	2.05E+05
Warfarin	81-81-2		308	1.70E+01	1.14E-07	9.19E+02	NA	1.63E-02	4.40E-06	1.16E-07	1.58E+03
Metals											
Aluminum	7429-90-5		27	NA	0.00E+00	NA	3.53E+02	NA	NA	NA	2.13E+00
Antimony	7440-36-0	0.006	122	NA	0.00E+00	NA	4.47E+01	NA	NA	NA	1.00E+00
Arsenic	7440-38-2	0.01	74.9	NA	NA	NA	2.90E+01	NA	NA	NA	4.78E+00
Barium	7440-39-3	2	137	NA	NA	NA	4.10E+01	NA	NA	NA	NA
Beryllium	7440-41-7	0.004	9	NA	0.00E+00	NA	7.90E+02	NA	NA	NA	3.72E+00
Cadmium	7440-43-9	0.005	112	NA	NA	NA	7.50E+01	NA	NA	NA	8.49E-01
Chromium (III) total chromium	7440-47-3	0.1	52	NA	NA	NA	1.80E+06	NA	NA	NA	NA
Chromium (VI)	18540-29-9		52	NA	NA	NA	1.90E+01	NA	NA	NA	NA
Copper	7440-50-8		64	NA	0.00E+00	NA	3.98E+01	NA	NA	NA	2.69E-01
Lead	7439-92-1	0.015	207	NA	NA	NA	1.00E+01	NA	NA	NA	5.36E+00
Manganese	7439-96-5		55	NA	0.00E+00	NA	5.01E+01	NA	NA	NA	1.00E+00
Mercury	7439-97-6		401	3.00E-02	4.67E-01	NA	5.20E+01	3.07E-02	6.30E-06	1.30E-03	3.38E-01
Molybdenum	7439-98-7		96	NA	0.00E+00	NA	2.00E+01	NA	NA	NA	1.00E+00
Nickel	7440-02-0		59	NA	0.00E+00	NA	6.50E+01	NA	NA	NA	2.69E-01
Selenium	7782-49-2	0.05	79	NA	NA	NA	5.00E+00	NA	NA	NA	1.73E+00
Silver	7440-22-4		108	NA	0.00E+00	NA	8.30E+00	NA	NA	NA	1.00E+00
Strontium	7440-24-6		88	NA	0.00E+00	NA	2.00E+00	NA	NA	NA	1.00E+00
Thallium chloride	7791-12-0		240	2.90E+03	0.00E+00	NA	7.10E+01	NA	NA	NA	NA

Table E-3
Physical and Chemical Properties of Chemicals

Chemicals	CAS #	MCL (mg/L)	Molecular Weight, MW (g/mol)	Water Solubility, S (mg/L)	Henry's Law Constant, H (L-water/L-air)	Organic Carbon Adsorption Coefficient, K _{oc} (cm ³ /g)	Soil-Water Partition Coefficient, K _d (L/kg)	Diffusion Coefficient in Air, D _a (cm ² /s)	Diffusion Coefficient in Water, D _w (cm ² /s)	Vapor Pressure, P (mmHg)	Octanol-Water Partition Coefficient, K _{ow} (cm ³ /g)
Vanadium	7440-62-2		51	NA	0.00E+00	NA	1.00E+03	NA	NA	NA	1.00E+00
Zinc	7440-66-6		65	NA	0.00E+00	NA	6.20E+01	NA	NA	NA	3.38E-01
Inorganics											
Ammonia	7664-41-7		17	5.31E+05	1.36E-02	3.09E+00	NA	2.59E-01	6.93E-05	7.47E+03	1.69E+00
Cyanide	57-12-5		26	1.00E+05	0.00E+00	NA	9.90E+00	5.21E-01	2.28E-05	1.38E+01	2.03E-01
Cyanide (as Sodium Cyanide)	143-33-9	0.2	49	5.80E+05	0.00E+00	NA	NA	NA	6.64E-06	NA	2.00E-02
Cyanogen bromide	506-68-3		106	8.50E+03	2.05E-01	2.60E+01	NA	9.60E-02	1.00E-05	NA	NA
Fluoride (as Sodium Fluoride)	7681-49-4	4	42	4.00E+04	0.00E+00	NA	NA	NA	6.15E-06	NA	1.70E-01
Perchlorate1	14797-73-0		99.5	2.00E+05	0.00E+00	NA	NA	NA	NA	NA	NA
White phosphorus	7723-14-0		31	3.00E+00	5.65E-02	1.12E+03	NA	1.85E-01	1.68E-05	2.50E-02	1.20E+03
Total Petroleum Hydrocarbons											
TPH-GR0											
Aliphatics -> C6-C8		NA	100	5.40E+00	5.00E+01	3.98E+03	NA	1.00E-01	1.00E-05	4.79E+01	NA
Aliphatics -> C8-C10		NA	130	4.30E-01	8.00E+01	3.16E+04	NA	1.00E-01	1.00E-05	4.79E+00	NA
Aromatics ->C8-C10		NA	120	6.50E+01	4.80E-01	1.58E+03	NA	1.00E-01	1.00E-05	4.79E+00	NA
TPH-DR0											
Aliphatics ->C10-C12		NA	160	3.40E-02	1.20E+02	2.51E+05	NA	1.00E-01	1.00E-05	4.79E-01	NA
Aliphatics ->C12-C16		NA	200	7.60E-04	5.20E+02	5.01E+06	NA	1.00E-01	1.00E-05	3.65E-02	NA
Aliphatics ->C16-C21		NA	270	2.50E-06	4.90E+03	6.31E+08	NA	1.00E-01	1.00E-05	8.40E-04	NA
Aromatics ->C10-C12		NA	130	2.50E+01	1.40E-01	2.51E+03	NA	1.00E-01	1.00E-05	4.79E-01	NA
Aromatics ->C12-C16		NA	150	5.80E+00	5.30E-02	5.01E+03	NA	1.00E-01	1.00E-05	3.65E-02	NA
Aromatics ->C16-C21		NA	190	6.50E-01	1.30E-02	1.58E+04	NA	1.00E-01	1.00E-05	8.36E-04	NA
TPH-ORO											
Aliphatics ->C21-C35		NA	270	2.50E-06	4.90E+03	6.31E+08	NA	1.00E-01	1.00E-05	8.40E-04	NA
Aromatics ->C21-C35		NA	240	6.60E-03	6.70E-04	1.26E+05	NA	1.00E-01	1.00E-05	3.34E-07	NA

Sources for properties:

Bold font:

CALM (1998) as revised in 2001, Table A4.

Bold and italic font:

EPA Region IX, PRGs InterCalc Tables: Phys-Chem Data (10/01/02).

Italic font:

Texas Comission on Environmental Quality's TRRP Chemical/Physical Properties Table; March, 2004.

Regular font:

Idaho Risk Based Decision-Making for Remedial Action Guidance Document, Appendix G, 2003.

Bold underlined font: Properties developed using the following equation:

$$D_1 = \left(\frac{MW_2}{MW_1} \right)^{1/2} \times D_2$$

where,

D₁ = Diffusuiion coefficient of chemical 1 (cm²/s)

D₂ = Diffusuiion coefficient of chemical 2 (cm²/s)

MW₁ = Molecular weight of chemical 1 (g/mol)

MW₂ = Molecular weight of chemical 2 (g/mol)

This equation comes from Handbook of Chemical Property Estimation Methods (Lyman et al., 1990).

Italic underlined font:

Soil Screening Guidance: User's Guide, Table C-4, July 1996, values corresponding to pH of 6.8 except for antimony, vandium, and cyanide which are non-pH dependent.

1: Water solubility for Perchlorate is from Hazardous Substance Databank, <http://toxnet.nlm.nih.gov/cgi-bin/sis/htmlgen?HSDB>.

MCLs: (Maximum Contaminant Level) USEPA (Winter 2004) Edition of Drinking Water Standards and Health Advisories.

Chemicals in MRBCA Process for Petroleum Storage Tanks

Table E-4
Exposure Factors

Parameter	Symbol	Unit	Default
Averaging Time for Carcinogen	AT _c	year	70
Averaging Time for Non-Carcinogen	AT _{nc}	year	=ED
Body Weight:			
Resident Child	BW	kg	15
Resident Adult	BW	kg	70
Non-Residential Worker	BW	kg	70
Construction Worker	BW	kg	70
Exposure Duration:			
Resident Child	ED	year	6
Resident Adult	ED	year	24
Non-Residential Worker	ED	year	25
Construction Worker	ED	year	1
Exposure Frequency:			
Resident Child	EF	day/year	350
Resident Adult	EF	day/year	350
Non-Residential Worker	EF	day/year	250
Construction Worker	EF	day/year	90
Soil Ingestion Rate:			
Resident Child	IR _{soil}	mg/day	200
Resident Adult	IR _{soil}	mg/day	100
Non-Residential Worker	IR _{soil}	mg/day	100
Construction Worker	IR _{soil}	mg/day	100
Groundwater Ingestion Rate:			
Resident Child	IR ^w	L/day	1
Resident Adult	IR ^w	L/day	2
Indoor Inhalation Rate (hourly):			
Resident Child	IR _i	m ³ /hr	0.416
Resident Adult	IR _i	m ³ /hr	0.833
Non-Residential Worker	IR _i	m ³ /hr	0.833
Exposure Time for Indoor Inhalation:			
Resident Child	ET _{in}	hr/day	18
Resident Adult	ET _{in}	hr/day	18
Non-Residential Worker	ET _{in}	hr/day	18
Indoor Inhalation Rate (daily)*:			
Resident Child	IR _a	m ³ /day	7.5
Resident Adult	IR _a	m ³ /day	15.0
Non-Residential Worker	IR _a	m ³ /day	15.0
Outdoor Inhalation Rate (hourly):			
Resident Child	IR _{ao}	m ³ /hr	0.416
Resident Adult	IR _{ao}	m ³ /hr	0.833
Non-Residential Worker	IR _{ao}	m ³ /hr	0.833
Construction Worker	IR _{ao}	m ³ /hr	1.62

Table E-4
Exposure Factors

Parameter	Symbol	Unit	Default
Exposure Time for Outdoor Inhalation:			
Resident Child	ET _{out}	hr/day	6
Resident Adult	ET _{out}	hr/day	6
Non-Residential Worker	ET _{out}	hr/day	6
Construction Worker	ET _{out}	hr/day	10
Outdoor Inhalation Rate (daily)**:			
Resident Child	IR _a	m ³ /day	2.5
Resident Adult	IR _a	m ³ /day	5.0
Non-Residential Worker	IR _a	m ³ /day	5.0
Construction Worker	IR _a	m ³ /day	16.2
Skin Surface Area for Incidental Dermal Contact with Soil:			
Resident Child	SA _{soil}	cm ² /day	2800
Resident Adult	SA _{soil}	cm ² /day	5700
Non-Residential Worker	SA _{soil}	cm ² /day	3300
Construction Worker	SA _{soil}	cm ² /day	3300
Skin Surface Area for Incidental Dermal Contact with Water:			
Resident Child	SA _{gw}	cm ² /day	2800
Resident Adult	SA _{gw}	cm ² /day	5700
Non-Residential Worker	SA _{gw}	cm ² /day	3300
Construction Worker	SA _{gw}	cm ² /day	3300
Skin Surface Area for Whole-Body Dermal Contact with Water:			
Resident Child	SA _{gw-wb}	cm ² /day	6600
Resident Adult	SA _{gw-wb}	cm ² /day	18000
Soil to Skin Adherence Factor:			
Resident Child	AF	mg/cm ²	0.2
Resident Adult	AF	mg/cm ²	0.07
Non-Residential Worker	AF	mg/cm ²	0.2
Construction Worker	AF	mg/cm ²	0.3
Event Frequency for Incidental Dermal Contact with Soil			
Resident Child	EV _{soil}	event/day	1
Resident Adult	EV _{soil}	event/day	1
Non-Residential Worker	EV _{soil}	event/day	1
Construction Worker	EV _{soil}	event/day	1
Event Frequency for Incidental Dermal Contact with Water			
Resident Child	EV _{gw}	event/day	1
Resident Adult	EV _{gw}	event/day	1
Non-Residential Worker	EV _{gw}	event/day	1
Construction Worker	EV _{gw}	event/day	1
Event Frequency for Whole-Body Dermal Contact with Water			
Resident Child	EV _{gw_wb}	event/day	1
Resident Adult	EV _{gw_wb}	event/day	1

Table E-4
Exposure Factors

Parameter	Symbol	Unit	Default
Event Duration for Incidental Dermal Contact with Water			
Resident Child	t _{event}	hr/event	1
Resident Adult	t _{event}	hr/event	1
Non-Residential Worker	t _{event}	hr/event	1
Construction Worker	t _{event}	hr/event	1
Event Duration for Whole-Body Dermal Contact with Water			
Resident Child	t _{event_wb}	hr/event	0.33
Resident Adult	t _{event_wb}	hr/event	0.25

Notes:

*: Calculated as hourly indoor inhalation rate times exposure time for indoor inhalation

**: Calculated as hourly outdoor inhalation rate times exposure time for outdoor inhalation

Table E-5
Fate and Transport Parameters

Parameter	Symbol	Unit	Soil Type 1	Soil Type 2	Soil Type 3
SOIL PARAMETERS:					
Soil Source Dimension Parallel to Wind Direction	W_a	cm	1500	1500	1500
Depth to Subsurface Soil Sources	d_{ts}	cm	91.44	91.44	91.44
Depth of Surficial Soil Zone	d_s	cm	91.44	91.44	91.44
Depth to Soil Vapor Measurement	d_{sv}	cm	91.44	91.44	91.44
VADOSE ZONE:					
Total Soil Porosity	θ_T	cm ³ /cm ³ -soil	0.38	0.44	0.44
Volumetric Water Content	θ_{ws}	cm ³ /cm ³	0.08	0.17	0.21
Volumetric Air Content	θ_{as}	cm ³ /cm ³	0.30	0.27	0.23
Thickness	h_v	cm	295	295	295
Dry Soil Bulk Density	ρ_s	g/cm ³	1.5	1.5	1.5
Fractional Organic Carbon Content	f_{ocv}	g-C/g-soil	0.006	0.006	0.006
SOIL IN CRACKS:					
Total Soil Porosity	θ_{Tcrack}	cm ³ /cm ³ -soil	0.38	0.44	0.44
Volumetric Water Content	θ_{wcrack}	cm ³ /cm ³	0.08	0.17	0.21
Volumetric Air Content	θ_{acrack}	cm ³ /cm ³	0.30	0.27	0.23
CAPILLARY FRINGE:					
Total Soil Porosity	θ_{Tcap}	cm ³ /cm ³ -soil	0.38	0.44	0.44
Volumetric Water Content	θ_{wcap}	cm ³ /cm ³	0.34	0.40	0.40
Volumetric Air Content	θ_{acap}	cm ³ /cm ³	0.038	0.044	0.044
Thickness	h_c	cm	5	5	5
GROUNDWATER PARAMETERS:					
Depth to Groundwater	L_{gw}	cm	300	300	300
GW Source Dimension Perpendicular to GW Flow Direction	Y	cm	1500	1500	1500
GW Source Dimension Parallel to GW Flow Direction	W_{ga}	cm	1500	1500	1500
Total Porosity in the Saturated Zone*	θ_{TS}	cm ³ /cm ³	0.38	0.44	0.44
Dry Soil Bulk Density (Saturated Zone)*	ρ_{ss}	g/cm ³	1.5	1.5	1.5
Fractional Organic Carbon Content in the Saturated Zone*	f_{ocs}	g-C/g-soil	0.006	0.006	0.006

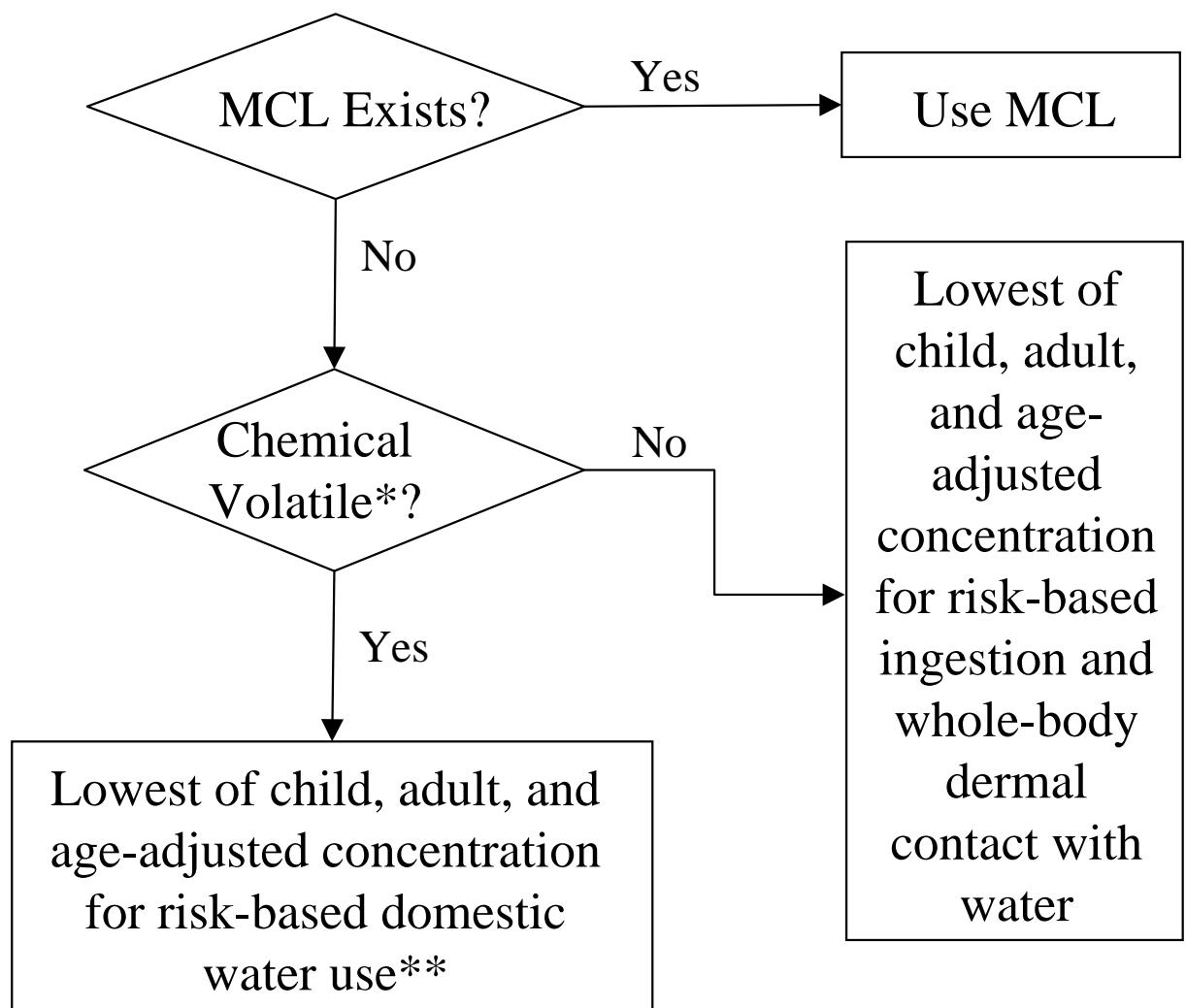
Table E-5
Fate and Transport Parameters

Parameter	Symbol	Unit	Soil Type 1	Soil Type 2	Soil Type 3
Groundwater Mixing Zone Thickness	δ_{gw}	cm	200	200	200
Hydraulic Conductivity in the Saturated Zone	K	cm/year	625000	625000	625000
Hydraulic Gradient in the Saturated Zone	i	cm/cm	0.004	0.004	0.004
Groundwater Darcy Velocity	U_{gw}	cm/year	2500	2500	2500
Infiltration Rate of Water Through Vadose Zone	I	cm/year	14	14	14
AMBIENT AIR PARAMETERS:					
Breathing Zone Height	δ_a	cm	200	200	200
Inverse of Mean Concentration at Center of Square Source	Q/C	(g/m ² -s)/(kg/m ³)	81.64	81.64	81.64
Fraction of Vegetative Cover	V	m ² /m ²	0.5	0.5	0.5
Mean Annual Wind Speed	U_m	m/s	4.69	4.69	4.69
Equivalent Threshold Value of Windspeed	U_t	m/s	11.32	11.32	11.32
Windspeed Distribution Function from Cowherd et. al, 1985	F(x)	unitless	0.194	0.194	0.194
ENCLOSED SPACE PARAMETERS:					
Enclosed Space Air Exchange Rate:					
Residential Structure	ER	1/24 hrs	12.096	12.096	12.096
Non-Residential Structure	ER	1/24hrs	19.872	19.872	19.872
Enclosed Space Volume/Infiltration Area:					
Residential Structure	L_B	cm	200	200	200
Non-Residential Structure	L_B	cm	300	300	300
Volatilization Factor for Domestic Water Use (K)					
Enclosed Space Foundation or Wall Thickness:					
Residential Structure	L_{crack}	cm	15	15	15
Non-Residential Structure	L_{crack}	cm	15	15	15
Area Fraction of Cracks in Foundation/Walls:					
Residential Structure	η	cm ² /cm ²	0.001	0.001	0.001
Non-Residential Structure	η	cm ² /cm ²	0.001	0.001	0.001

Notes:

The values in **bold** are calculated.

* These parameters not used for DTL or Tier 1 RBTL caculations, but may be required for Tier 2 SSTLs.



MCL: Maximum contaminant level

* Chemical is volatile if MW < 200 and H (dimensionless) > 4.2×10^{-4} .

** Domestic water use includes ingestion of water, indoor inhalation of vapors due to water use, and dermal contact.

Figure E-1. Determination of Groundwater Target Concentration at POE

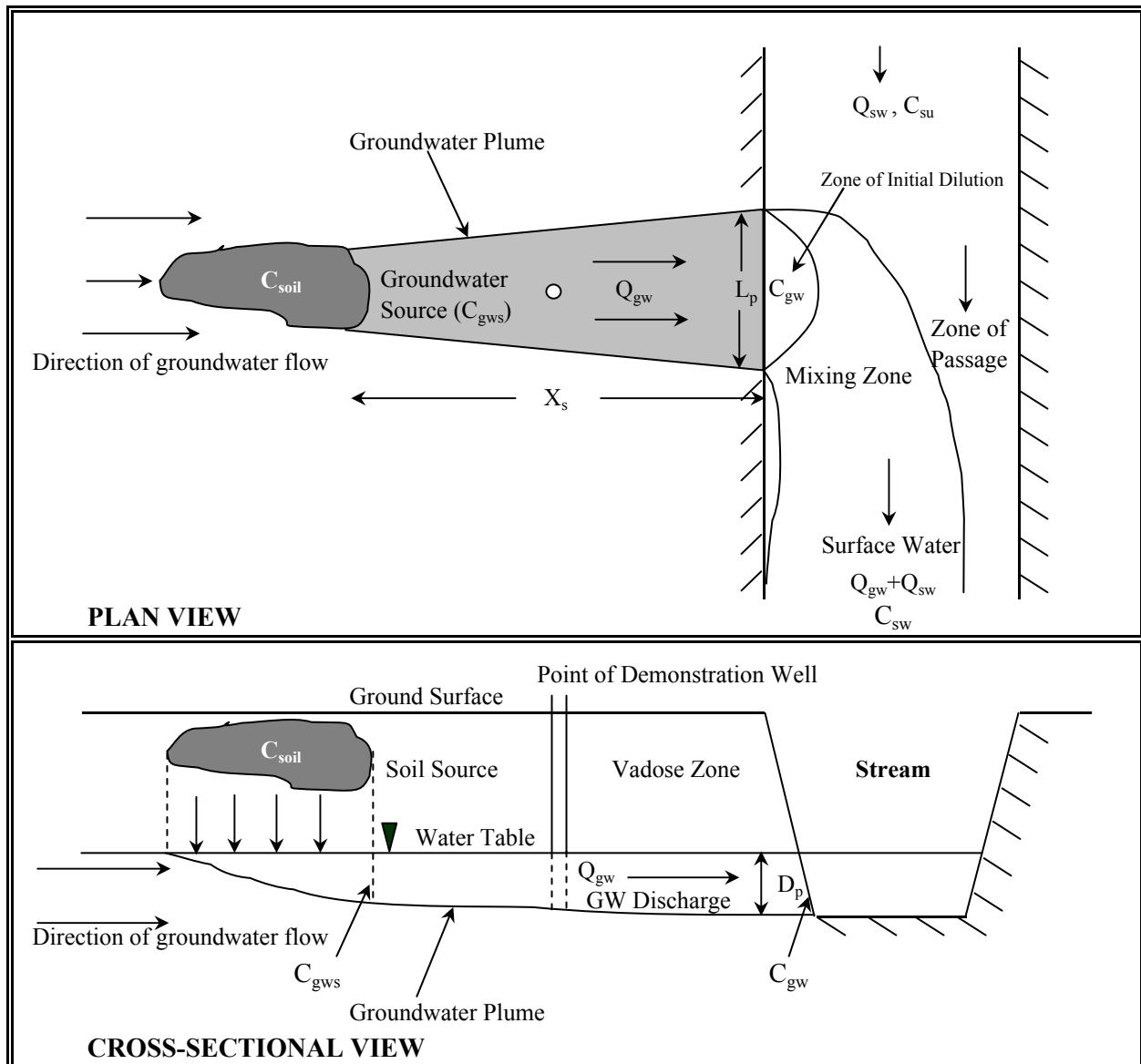


Figure E-2. Schematic of Leachate Migration from the Soil to a Stream

Explanation of Symbols

- Q_{sw} = Stream flow upstream of the point of groundwater discharge [ft³/day]
- C_{su} = Concentration upstream of the groundwater discharge [mg/L]
- Q_{gw} = Impacted groundwater discharge into the stream [ft³/day]
- C_{sw} = Allowable downstream concentration, i.e., specific water quality criteria to be met beyond mixing zone [mg/I]
- C_{gw} = Allowable concentration in the groundwater discharge to the stream [mg/L]
- C_{gws} = Allowable concentration in the groundwater at the edge of the soil source [mg/L]
- C_{soil} = Allowable soil concentration at the source [mg/kg]
- L_p = Width of groundwater plume discharging to the stream [ft]
- D_p = Thickness of groundwater plume discharging to the stream [ft]
- X_s = Distance from the downgradient edge of the groundwater source to the stream [ft]

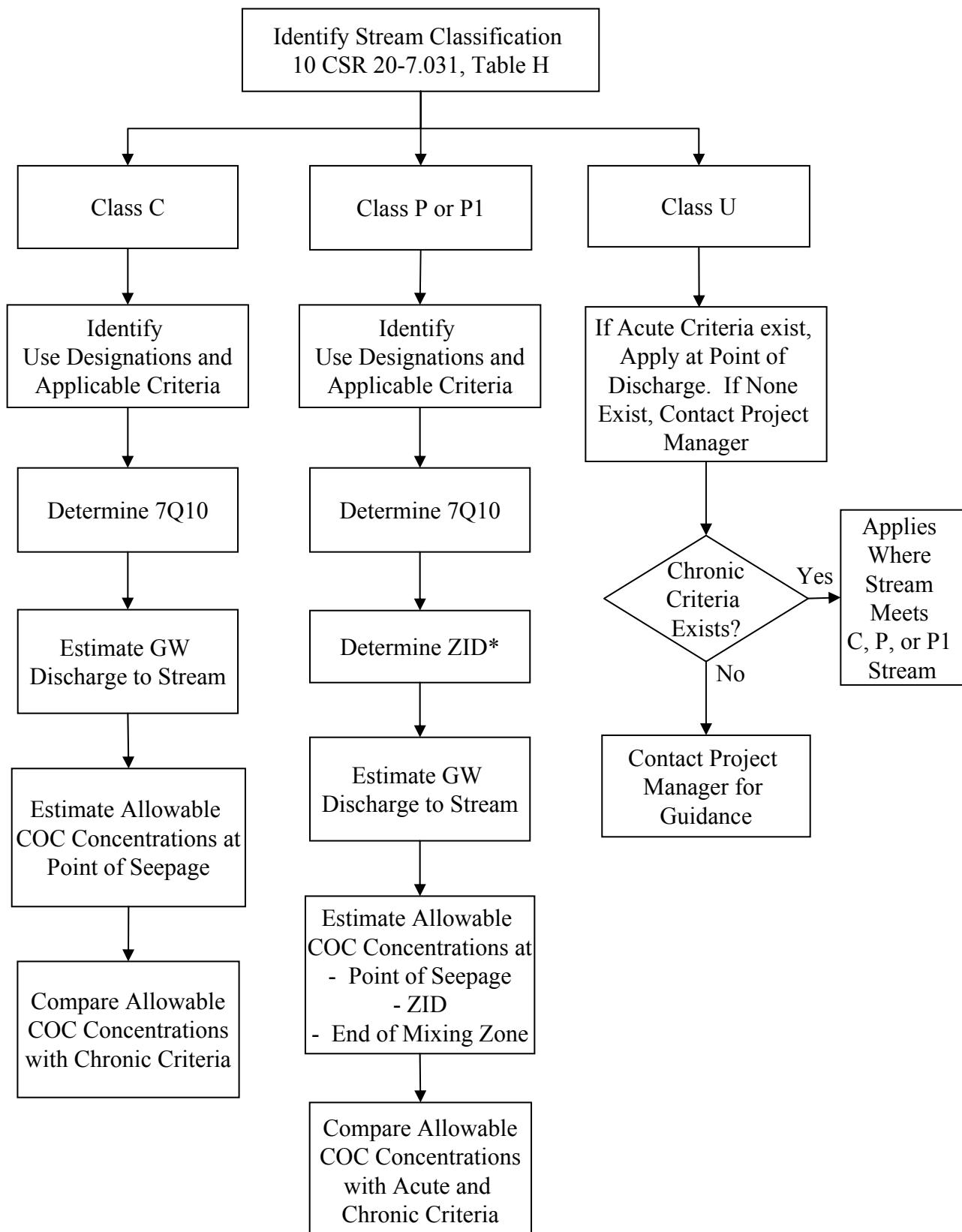


Figure E-3. Procedure for Protection of Stream Body